IAEG COMMISSION C37
LANDSLIDE NOMENCLATURE

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Past President: Prof. David Cruden
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REPORT ON ACTIVITIES – 2022

Background:

The International Geotechnical Societies' UNESCO Working Party on World Landslide Inventory (WP/WLI) was initiated at the 5th International Symposium on Landslides (Lausanne 1988) to assist the establishment of a detailed list of the World's landslides. The Working Party was composed of the members of the Technical Committee on Landslides (TC 11) of the International Society for Soil Mechanics and Geotechnical Engineering, the Commission on Landslides of the International Association of Engineering Geology and the Environment (IAEG Commission 2), and nominees of National Groups of the International Society of Rock Mechanics (ISRM). The Working Party later became a Working Group of the International Union of Geological Sciences (IUGS) after the ISSMFE and the ISRM joined the IUGS, and with the addition of nominees from the International Association of Geomorphologists (IAG). The scientific goal of the Working Group was to assist in the prediction of the occurrence and behaviour of landslides during the International Decade for Natural Disaster Reduction (1990-2000).

A common nomenclature was regarded as necessary to assist mutual understanding. The efforts to this end lead to consensus regarding suggested nomenclature and methods, published in a series of articles. These include A Suggested Method for Reporting a Landslide (WP/WLI 1990a), Suggested Nomenclature for landslides (WP/WLI 1990b), a simple definition of landslide (Cruden 1991),A Suggested Method for a Landslide Summary (WP/WLI 1991),A Suggested Method for describing the Activity of a Landslide (WP/WLI 1993a),A Suggested Method for reporting Landslide Causes (WP/WLI 1994), A Suggested Method for describing the Rate of Movement of a Landslide (IUGS/WG/L 1995), and A Suggested Method for reporting Landslide Remedial Measures (IUGS/WG/L 2001). Some of these were collected in the Multilingual Landslide Glossary (WP/WLI 1993b). They formed the basis of the Working Classification of Landslides (Cruden, Lan, 2014)

The Working Group also turned its attention to risk assessment associated with landslide phenomena, holding a workshop in Honolulu, Hawaii in 1997. The proceedings of the workshop (Cruden, Fell,1997) included papers on landslide risk assessment practice, approaches to risk assessment and management, and others that covered the state of the art for landslide risk management.

At the end of the IDNDR, the Working Group asked its active committees to reintegrate with their parent organizations (Cruden, 2001). The incomplete Multilingual Glossary became a responsibility of IAEG Commission 2. Unfortunately, this Commission was subsequently stood down. Discussions at the IAEG 2014 Congress led to its revival to address the limited field of Landslide Nomenclature.

The annual IAEG council meeting was held in New Delhi, India, during the International Conference on Engineering Geology in the New Millennium, October 25th and 26th, 2015. The president of IAEG, Professor Scott Burns, chaired the meetings. Dr. Hengxing Lan reported on the establishment of a new IAEG commission on Landslide Nomenclature. Through the discussion and vote at the council meeting, the new Commission on LANDSLIDE NOMENCLATURE was established and assigned the number C37.

Commission 37 on Landslide nomenclature held the first meeting in NAPOLI, Italy, June 13 and submitted its first annual report since Dr. Lan started its period as chair in 2016. The second meeting of the commission was held in Ljubljana, Slovenia, in June 1st, 2017, during the 4th World Landslide Forum. The third meeting was held on September 17, 2018; during the 2018 IAEG meeting in San Francisco, CA.

Activities in the period 2021-2022:

Call for membership

The Chair of the Commission continued the task of gathering members for the commission appointed or suggested by the national groups as the working parties continue to assemble for the development and translation of the nomenclature.

The list of members up to date is appended to this document **(Appendix 0).**

IAEG C37 publications:

Four papers based on the work of IAEG C37 have been published during the period of 2021-2022. One was published in Engineering Geology. Two were published in Landslides. One was published in World Landslide Forum 5.

Lan, H.X., Tian, N.M., Li, L.P., Wu, Y.M., Macciotta, R., Clague, J.J. (2022). Geological Disaster Risk Management for the Sichuan-Tibet Grid Interconnection Project in China. Engineering Geology, 308, 106823.

LI LP, LAN HX, Strom A, MACCIOTTA R, 2022. Landslide longitudinal shape: a new concept for complementing landslide aspect ratio. Landslides 19, 1143–1163.

LI LP, LAN HX, Strom A, MACCIOTTA R, 2022. Landslide length, width, and aspect ratio: path-dependent measurement and a revisit of nomenclature. Landslides, online.

Strom, A. (2021). Rock avalanches: basic characteristics and classification criteria. In Workshop on World Landslide Forum (pp. 3-23). Springer, Cham.

IAEG C37 meeting:

Due to the ongoing and fluid situation with COVID-19, a meeting was not possible.

Tasks continued:

Nomenclature: Rate of Movement

Chair: Prof. Hengxing Lan (Lanhx@igsnrr.ac.cn)

Finalized and in the process of publication in UNESCO languages and other popular languages.

Details in Appendix A

Nomenclature: Water Conditions

Chair: Dr. Ann Williams (ann.williams@beca.com)

Draft has been circulated and discussions are ongoing regarding some suggestions presented. Current working on finalization.

Water Condition Descriptors are proposed. The team proposes both a displaced mass descriptor and a failure plane descriptor where this can be determined. Key questions have been addressed. They are:
1) Should ground water levels relative to surface of rupture be considered?
2) Should such water level be associated with water conditions?
3) Should include values for Liquidity Index and Consistency Index for soils with high-clay content?
4) The graphing issue with regard to the water content.

It is planned to include photographs and illustrations in the descriptor table.

Details in Appendix B

Nomenclature: Types of Material

Chair: Prof. Tomás Fernandes-Steeger (fernandez-steeger@tu-berlin.de)

Under development. Current working draft in **Appendix C.**

Nomenclature: Landslide Risk

Chair: Prof. Jordi Corominas (jordi.corominas@upc.edu)

Finalized, in the process of publication in UNESCO languages and other popular languages.

A paper promoted by the task published on the journal Engineering Geology.

Details in Appendix D.

Nomenclature: Type of Landslide

Chair: Prof. Alexander Strom (strom.alexandr@yandex.ru)

Inclusion of special types of rock avalanche is under discussion and sub-committee is being set up, and published a paper in World Landslide Forum 5. Specifically, classification of rock avalanches is elaborated, combined with the transition from blockslides to flowslides (rock avalanches). Additional classification criteria are:
1. Confinement conditions;
2. Material distribution along RA travel path;
3. Debris motion directivity.

In addition, Landslide geometrical characterization has been developed and published two papers on the journal Landslides.

Details in Appendix E.

Nomenclature: Landslide Volume

Chair: Dr. Phil Flentje (pflentje@uow.edu.au)

The landslide volume classification scheme has been proposed and under development in the light of comments.

Details in Appendix F.

References:

Cruden DM (2001) IUGS Working Group on World Landslide Inventory and the IDNDR (1990-2000). Episodes 24(3): 209-210

Cruden DM, Fell,R,,editors (1997 Landslide Risk Assessment, Balkema, Rotterdam, 371p.

Cruden DM, Lan, HX,2014, Using the Working Classification of Landslides to assess the Danger from a Natural Slope, Proceedings 12th.International Congress of Engineering Geology.

WP/WLI: International Geotechnical Societies' UNESCO Working Party on World Landslide Inventory (1990a) A suggested method for reporting a landslide. Bull IAEG 41: 5–12

WP/WLI: International Geotechnical Societies' UNESCO Working Party on World Landslide Inventory (1990b) Suggested Nomenclature for Landslides. Bull IAEG 41: 13–16

Cruden DM (1991) A Simple Definition of a Landslide. Bull IAEG 43: 27–29

WP/WLI: International Geotechnical Societies' UNESCO Working Party on World Landslide Inventory (1991) A Suggested Method for a Landslide Summary. Bull IAEG 43: 101–110

WP/WLI: International Geotechnical Societies' UNESCO Working Party on World Landslide Inventory. Working Group on Landslide Activity (1993a) A Suggested Method for Describing the Activity of a Landslide. Bull IAEG 47: 53–57

WP/WLI: International Geotechnical Societies' UNESCO Working Party on World Landslide Inventory, Working Group on Landslide Causes (Chairman: ME Popescu) (1994) A Suggested Method for Reporting Landslide Causes. Bull IAEG 50: 71–74

IUGS Working Group on Landslides (1995) A Suggested Method for Describing the Rate of Movement of a Landslide. Bull IAEG 52: 75–78

IUGS Working Group on Landslides (2001) A Suggested Method for Reporting Landslide Remedial Measures. Bull Eng Geol Env 60: 69–74

IUGS Working Group on Landslides (2001) A Suggested Method for Reporting Landslide Remedial Measures. Bull Eng Geol Env 60: 69–74

WP/WLI: International Geotechnical Societies' UNESCO Working Party on World Landslide Inventory (1993) Multilingual landslide glossary. Bitech, Richmond, British Columbia

IAEG NEWSLETTER. Electronic Version Issue No.2, 2015

Lan, H.X., Tian, N.M., Li, L.P., Wu, Y.M., Macciotta, R., Clague, J.J. (2022). Geological Disaster Risk Management for the Sichuan-Tibet Grid Interconnection Project in China. Engineering Geology, 308, 106823.

LI LP, LAN HX, Strom A, MACCIOTTA R, 2022. Landslide longitudinal shape: a new concept for complementing landslide aspect ratio. Landslides 19, 1143–1163.

LI LP, LAN HX, Strom A, MACCIOTTA R, 2022. Landslide length, width, and aspect ratio: path-dependent measurement and a revisit of nomenclature. Landslides, online.

Strom, A. (2021). Rock avalanches: basic characteristics and classification criteria. In Workshop on World Landslide Forum (pp. 3-23). Springer, Cham.

Appendix 0: IAEG C37 Membership

IAEG Commission - C37 Landslide Nomenclature

Membership

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Secretary: Dr. Renato Macciotta (**Canada**) macciott@ualberta.ca

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Representatives (Ordered by Continent and Country)

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Australasia

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Prof. Cristian Marunteanu **(Romania)** crimarunteanu@yahoo.com, cristian.marunteanu@g.unibuc.ro Language Leader: Romanian

Prof. Alexander Strom (**Russia**) strom.alexandr@yandex.ru Task Leader: Type of Landslide; Language Leader: Russian

Dr Srđan Kostić **(Serbia)** Srdjan.Kostic@jcerni.co.rs Task Leader: Compilation of Case histories (not available, pending to change); Language Leader: Serbian

Prof. Jordi Corominas (**Spain**) jordi.corominas@upc.edu Task Leader: Landslide Risk; Language Leader: Spanish

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Prof. Nicola Sciarra (**Italy**) nsciarra@unich.it

Appendix A: Nomenclature: Rate of Movement

English

Rate of Landslide Movement (Velocity)

The rate of movement presented by Varnes (1978) had 7 divisions ranging from 3 metres/second to 0.06 metres/year. Varnes (1978) did not discuss the selection of the seven divisions of the scale. Nemcok et al. (1972) suggested a four-fold division of a similar range of velocities.

The IUGS Working Group on Landslides (1995) proposed to retain the seven divisions included in the Varnes scale, but suggested the limits be slightly adjusted so that all divisions of the scale are multiples of 100. The proposed limits span ten orders of magnitude in the scale, between 16 mm/year and 5 m/second. The Working Group further correlated the seven classes of velocity with potential situations and damage, ranging from "No Damage" for structures built on landslides showing the slowest velocities, to "Catastrophe of Major Violence" for structures and people on or within landslides showing the fastest velocities.

The adjusted velocity classes of landslide movement and their associated consequences were presented by Cruden and Varnes (1996). Cruden and Lan (2015) suggested that the velocity classes can be correlated with observed consequences although rates of movement within a landslide differ with position, elapsed time and the time interval over which the rate is estimated.

References:

Varnes, D.J. 1978. Slope Movement Types and Processes. In Landslides: Analysis and Control. Schuster & Krizek (eds.). Transportation Research Board, National Academy of Sciences, Washington, DC. Special Report 176:11-33

Nemcok, A., Pasek, J., Rybar, J. 1972. Classification of Landslides and Other Mass Movements. Rock Mechanics 4:71-78

IUGS Working Group on Landslides (1995) A Suggested Method for Describing the Rate of Movement of a Landslide. Bull IAEG 52: 75–78

Cruden, D.M., Varnes, D.J., 1996. Landslide types and processes. In:Turner AK, Schuster RL (eds) Landslides: investigation and mitigation, vol 247. U.S. Transportation Research Board, Special Report, pp 36–75.

Cruden, D.M. and Lan, H.X.2015. Using the Working Classification of Landslides to Assess the Danger from a Natural Slope. G. Lollino et al. (eds.), Engineering Geology for Society and Territory – Volume 2, DOI: 10.1007/978-3-319-09057-3_1, © Springer International Publishing Switzerland 2015, pp 3-12.

Classes of Landslide Velocity

7 – Extremely rapid

6 – Very rapid

5 – Rapid

4 – Moderate

3 – Slow

2 – Very slow

1 – Extremely slow

Table 1: Velocity classes

Velocities in the table indicate boundaries between classes

	1	2	3
7	5×10^3	10^4	
6			
5	50	10^2	
4			16×10^3
3	0.5	1	
2			160
	5×10^{-3}	10^{-2}	
			1.6
1	5×10^{-6}	10^{-4}	
			16×10^{-3}
	0.5×10^{-6}	10^{-6}	

Column 1 shows the boundaries between classes in millimetres per second.
Column 2 shows the approximate boundaries between classes in metres per hour.
Column 3 shows the boundaries between classes in metres per year

Table 2 Alternative format of landslide velocity classes

Class	Description	Velocity	mm/sec
7	**Extremely Rapid**		
	-------- ------------------	5m/sec	5×10^3

6	**Very Rapid**		
	-------- -------------------	3m/minute	50
5	**Rapid**		
	-------- -------------------	1.8m/hr	0.5
4	**Moderate**		
	-------- -------------------	3m/week	5 x 10^{-3}
3	**Slow**		
	-------- -------------------	1.6m/year	50 x 10^{-6}
2	**Very Slow**		
	-------- -------------------	16mm/year	0.5 x 10^{-6}
1	**Extremely Slow**		

Velocities in the table indicate boundaries between classes

Chinese

滑坡速率

Varnes (1978)把滑坡的移动速率分为 7 个等级，从 3 米/每秒到 0.06 米/每年。Varnes (1978)在文中并没有讨论如何选择这 7 个等级的尺度。Nemcok et al. (1972)建议在上述类似的速度范围内采用 4 个等级的方法来划分。

IUGS Working Group （工作小组）on Landslides (1995) 提出保留 Varnes 关于 7 个等级和尺度的方法，但是建议对上下限做轻微调整，因此所有等级的尺寸都乘以 100. 提出的上下界限从 16 毫米/每年到 5 米/每秒在尺度上相差 10 个数量级。这个工作小组进一步将这 7 个等级与潜在的受损情况联系起来，从位于在滑坡上没有受损的构筑物，往往对应着最小的移动速度，到发生重大暴力灾难，对应着滑坡体内构筑物和人最快的移动速度。

Cruden and Varnes (1996)介绍了调整过的滑坡速度等级方法及其相关影响。Cruden and Lan (2015)建议将速度等级和观察到的结果联系起来，即便滑坡内部各点的移动速率、持续时间和时间区间都不一样。

References（参考文献）:

Varnes, D.J. 1978. Slope Movement Types and Processes. In Landslides: Analysis and Control. Schuster & Krizek (eds.). Transportation Research Board, National Academy of Sciences, Washington, DC. Special Report 176:11-33

Nemcok, A., Pasek, J., Rybar, J. 1972. Classification of Landslides and Other Mass Movements. Rock Mechanics 4:71-78

IUGS Working Group on Landslides (1995) A Suggested Method for Describing the Rate of Movement of a Landslide. Bull IAEG 52: 75–78

Cruden, D.M., Varnes, D.J., 1996. Landslide types and processes. In:Turner AK, Schuster RL (eds) Landslides: investigation and mitigation, vol 247. U.S. Transportation Research Board, Special Report, pp 36–75.

Cruden, D.M. and Lan, H.X.2015. Using the Working Classification of Landslides to Assess the Danger from a Natural Slope. G. Lollino et al. (eds.), Engineering Geology for Society and Territory – Volume 2, DOI: 10.1007/978-3-319-09057-3_1, © Springer International Publishing Switzerland 2015, pp 3-12.

Classes of Landslide Velocity （滑坡速度等级）

7 – Extremely rapid （极快）

6 – Very rapid （非常快）

5 – Rapid （快）

4 – Moderate （中）

3 – Slow（慢）

2 – Very slow （非常慢）

1 – Extremely slow （极慢）

Table 1: Velocity classes （表 1. 速度等级）

Velocities in the table indicate boundaries between classes （表中速度代表不同等级的界限）

	1	2	3
7	5×10^{3}	10^{4}	
6			
5	50	10^{2}	
4			16×10^{3}
3	0.5	1	
2			160
	5×10^{-3}	10^{-2}	
			1.6
1	5×10^{-6}	10^{-4}	
			16×10^{-3}
	0.5×10^{-6}	10^{-6}	

Column 1 shows the boundaries between classes in millimetres per second. （第一列以毫米/每秒为单位）
Column 2 shows the approximate boundaries between classes in metres per hour. （第二列以米/每小时为单位）
Column 3 shows the boundaries between classes in metres per year（第二列以米/每年为单位）

Table 2 Alternative format of landslide velocity classes （表 2 滑坡速度等级的其他形式）

Class（等级）	**Description（描述）**	**Velocity（速度）**	**mm/sec（毫米/每秒）**
7	**Extremely Rapid（极快）**		5×10^{3}
	-------- -----------------	5m/sec （米/每秒）	
6	**Very Rapid（非常快）**		50
	-------- -----------------	3m/minute（米/每分钟）	
5	**Rapid（快）**		0.5
	-------- ----------------	1.8m/hr（米/每小时）	
4	**Moderate（中）**		5×10^{-3}
	-------- -----------------	3m/week（米/每周）	
3	**Slow（慢）**		50×10^{-6}
	-------- --------------	1.6m/year（米/每年）	
2	**Very Slow（非常慢）**		0.5×10^{-6}
	-------- -------------	16mm/year （毫米/每年）	
1	**Extremely Slow（极慢）**		

Spanish

Tasa de Movimiento de los Deslizamientos (Velocidad)

La tasa de movimiento presentada por Varnes (1978) contenía 7 divisiones que variaban desde los 3 m/s a 0,06 m/año. Varnes (1978) no comentó la selección de las siete divisiones de la escala. Nemcok et al. (1972) sugirieron una cuádruple división con un rango similar de velocidades.

El Grupo de Trabajo sobre Deslizamientos de la IUGS (1995) propuso mantener las siete divisiones incluidas en la escala de Varnes, pero sugirió que los límites se ajustaran ligeramente de modo que las divisiones de la escala fueran múltiplos de 100. Los límites propuestos abarcan diez órdenes de magnitud, entre los 16 mm / año y los 5 m /s. El Grupo de Trabajo correlacionó además las siete clases de velocidad con situaciones potenciales y los daños, desde "No Daño" para las estructuras construidas en los deslizamientos que muestran las velocidades más lentas, hasta "Catástrofe de Violencia Mayor" para estructuras y personas en o dentro los deslizamientos que muestran las velocidades más rápidas.

Cruden y Varnes (1996) presentaron las clases de velocidad ajustadas de los deslizamientos y las consecuencias asociadas. Cruden y Lan (2015) sugirieron que las clases de velocidad pueden correlacionarse con las consecuencias observadas, aunque las tasas de movimiento en un deslizamiento difieren con la posición, el tiempo transcurrido y el intervalo de tiempo durante el cual se estima la tasa.

Bibliografía:

Varnes, D.J. 1978. Slope Movement Types and Processes. In Landslides: Analysis and Control. Schuster & Krizek (eds.). Transportation Research Board, National Academy of Sciences, Washington, DC. Special Report 176:11-33

Nemcok, A., Pasek, J., Rybar, J. 1972. Classification of Landslides and Other Mass Movements. Rock Mechanics 4:71-78

IUGS Working Group on Landslides (1995) A Suggested Method for Describing the Rate of Movement of a Landslide. Bull IAEG 52: 75–78

Cruden, D.M., Varnes, D.J., 1996. Landslide types and processes. In:Turner AK, Schuster RL (eds) Landslides: investigation and mitigation, vol 247. U.S. Transportation Research Board, Special Report, pp 36–75.

Cruden, D.M. and Lan, H.X.2015. Using the Working Classification of Landslides to Assess the Danger from a Natural Slope. G. Lollino et al. (eds.), Engineering Geology for Society and Territory – Volume 2, DOI: 10.1007/978-3-319-09057-3_1, © Springer International Publishing Switzerland 2015, pp 3-12.

Clases de velocidad de deslizamiento

7 - Extremadamente rápido
6 - Muy rápido
5 - Rápido
4 - Moderado
3 - Lento
2 - Muy lento
1 - Extremadamente lento

Tabla 1: Clases de velocidad

Las velocidades en la tabla indican los límites entre las clases

	1	2	3
7	5×10^{3}	10^{4}	
6			
5	50	10^{2}	
4			16×10^{3}
3	0.5	1	
2			160
	5×10^{-3}	10^{-2}	
			1.6
1	5×10^{-6}	10^{-4}	
			16×10^{-3}
	0.5×10^{-6}	10^{-6}	

La columna 1 muestra los límites entre las clases en milímetros por segundo.

La columna 2 muestra los límites aproximados entre las clases en metros por hora.

La columna 3 muestra los límites entre las clases en metros por año

Romanian

Viteza de deplasare a alunecărilor de teren

Clasificarea vitezelor de deplasare prezentată de Varnes (1978) are 7 diviziuni cuprinse între 3 metri/secundă şi 0,06 metri/an. Varnes (1978) nu a discutat selecţia celor 7 diviziuni ale scării. Nemcok et al. (1972) a sugerat 4 diviziuni într-un interval similar de viteze.

IUGS Working Group on Landslides (1995) a propus să se reţină cele 7 diviziuni incluse în scara lui Varnes, dar a dugerat ca limitele să fie puţin ajustate astfel încât toate diviziunile scării să fie multipli de 100. Limitele propuse acoperă zece ordine de mărime în scară, între 16 mm/an şi 5 m/secundă. Acelaşi Working Group a corelat în continuare cele şapte clase de viteză cu situaţii potenţiale şi pagube, cuprinse între „Nici o pagubă" pentru structuri construite pe alunacări de teren cu cele mai lente viteze, până la „Catastofă de violenţă majoră" pentru structuri şi populaţie pe sau în alunecări de teren cu vitezele cele mai mari.

Clasele de viteză ajustate ale deplasărilor alunecărilor de teren şi consecinţele lor asociate au fost prezentate de Cruden şi Varnes (1996). Cruden şi Lan (2015) au sugerat că aceste clase de viteză pot fi corelate cu consecinţele observate, deşi vitezele de deplasare pentru o alunecare de teren diferă cu poziţia, durata şi intervalul de timp pentru care viteză a fost estimată.

Referinţe:

Varnes, D.J. 1978. Slope Movement Types and Processes. In Landslides: Analysis and Control. Schuster & Krizek (eds.). Transportation Research Board, National Academy of Sciences, Washington, DC. Special Report 176:11-33

Nemcok, A., Pasek, J., Rybar, J. 1972. Classification of Landslides and Other Mass Movements. Rock Mechanics 4:71-78

IUGS Working Group on Landslides (1995) A Suggested Method for Describing the Rate of Movement of a Landslide. Bull IAEG 52: 75–78

Cruden, D.M., Varnes, D.J., 1996. Landslide types and processes. In:Turner AK, Schuster RL (eds) Landslides: investigation and mitigation, vol 247. U.S. Transportation Research Board, Special Report, pp 36–75.

Cruden, D.M. and Lan, H.X.2015. Using the Working Classification of Landslides to Assess the Danger from a Natural Slope. G. Lollino et al. (eds.), Engineering Geology for Society and Territory – Volume 2, DOI: 10.1007/978-3-319-09057-3_1, © Springer International Publishing Switzerland 2015, pp 3-12.

Clasele de viteză ale alunecărilor de teren

7 – Extrem de rapidă

6 – Foarte rapidă

5 – Rapidă

4 – Moderată

3 – Lentă

2 – Foarte lentă

1 – Extrem de lentă

Tabelul 1: Clasele de viteză

Vitezele din tabel indică limitele dintre clase

	1	2	3
7			
	5×10^3	10^4	
6			
	50	10^2	
5			
	0.5	1	16×10^3
4			
	5×10^{-3}	10^{-2}	160
3			
	5×10^{-6}	10^{-4}	1,6
2			
	0.5×10^{-6}	10^{-6}	16×10^{-3}
1			

Coloana 1 arată limitele dintre clase în mm/s

Coloana 2 arată limitele aproximative dintre clase în m/h

Coloana 3 arată limitele dintre clase în m/an

1.

2. Table 2 Format alternative al claselor de viteză ale alunecărilor de teren

3.

Clasa	Descrierea	Viteza	mm/s
7	**Extrem de rapidă**		
	-------- -------------------	5 m/s	5 x 10^{3}
6	**Foarte rapidă**		
	-------- -------------------	3 m/min	50
5	**Rapidă**		
	-------- -------------------	1,8 m/h	0,5
4	**Moderată**		
	-------- -------------------	3 m/săptămână	5 x 10^{-3}
3	**Lentă**		
	-------- -------------------	1,6 m/an	50 x 10^{-6}
2	**Foarte lentă**		
	-------- -------------------	16 mm/an	0.5 x 10^{-6}
1	**Extrem de lentă**		

Valorile din tabel indică limitele dintre clase

Tabla 2 Formato alternativo de clases de velocidad de deslizamiento

Clase	Descripción	Velocidad	mm/s
7	**Extremadamente rápido**		
	-------- -------------------	5m/s	5 x 10^{3}
6	**Muy rápido**		
	-------- -------------------	3m/min	50
5	**Rápido**		

	-------- -------------------	1.8m/h	0.5
4	**Moderado**		
	-------- -------------------	3m/semana	5×10^{-3}
3	**Lento**		
	-------- -------------------	1.6m/año	50×10^{-6}
2	**Muy lento**		
	-------- -------------------	16mm/año	0.5×10^{-6}
1	**Extremadamente lento**		

Las velocidades en la tabla indican los límites entre las clases

Serbian

Класификација клизишта према брзини померања

Класификација клизишта према брзини померања предложена од стране Варнеса (1978) обухватила је 7 класа брзина у интервалу од 3 m/s до 0,06 m/god, при чему нису разматрани разлози издвајања 7 класа. Немчок и др. (1972) предложили су поделу на четири класе са сличним распоном брзина померања клизишта.

Радна група за клизишта Међународне уније геолошких наука (IUGS) 1995.г. изнела је предлог да се задржи класификација Варнеса, с тим да би распоне вредности за поједине класе требало прилагодити тако да се могу изразити у систему са основном 10, $m \times 10^n$. При томе, предложене границе између појединих класа обухватају распон од 10^{10} редова величине, између 16mm/god. и 5m/s. Радна група је даље извршила корелацију Варнесових седам класа брзина са потенцијалним догађајима и штетама, у распону од ,,Нема штете" за објекте на клизишту са најмањом брзином померања, до ,,Катастрофе великих размера" за објекте и људе на клизишту или у зони утицаја клизишта, са највећим брзинама померања.

Прилагођене класе брзина померања клизишта и опис одговарајућих штета/последица презентоване су од стране Крудена и Варнеса (1996). Круден и Лан (2015) изнели су став да, премда се класе брзине померања могу корелисати са последицама, брзине померања клизишта није униформна за цело тело клизишта, а зависи и од протеклог времена од почетка кретња клизишта, као и од временског периода за који се брзина померања процењује.

Референце:

Varnes, D.J. 1978. Slope Movement Types and Processes. In Landslides: Analysis and Control. Schuster & Krizek (eds.). Transportation Research Board, National Academy of Sciences, Washington, DC. Special Report 176:11-33

Nemcok, A., Pasek, J., Rybar, J. 1972. Classification of Landslides and Other Mass Movements. Rock Mechanics 4:71-78

IUGS Working Group on Landslides (1995) A Suggested Method for Describing the Rate of Movement of a Landslide. Bull IAEG 52: 75–78

Cruden, D.M., Varnes, D.J., 1996. Landslide types and processes. In:Turner AK, Schuster RL (eds) Landslides: investigation and mitigation, vol 247. U.S. Transportation Research Board, Special Report, pp 36–75.

Cruden, D.M. and Lan, H.X.2015. Using the Working Classification of Landslides to Assess the Danger from a Natural Slope. G. Lollino et al. (eds.), Engineering Geology for Society and Territory – Volume 2, DOI: 10.1007/978-3-319-09057-3_1, © Springer International Publishing Switzerland 2015, pp 3-12.

Класе брзина промерања клизишта

1. **7 – Екстремно брзо**
2. **6 – Врло брзо**
3. **5 – Брзо**
4. **4 – Умерено**
5. **3 – Споро**
6. **2 – Врло споро**
7. **1 – Екстремно споро**
8.
9. **Табела 1: Класе брзина померања**
10. **Брзине у табели представљају границе између појединих класа**

	1	2	3
7	5×10^3	10^4	
6			
5	50	10^2	
4			16×10^3
3	0.5	1	
2			160
	5×10^{-3}	10^{-2}	
			1.6
1	5×10^{-6}	10^{-4}	
			16×10^{-3}
	0.5×10^{-6}	10^{-6}	

Колона 1 показује границе између класа у mm/s
Колона 2 показује приближне границе у m/h
Колона 3 показује границе између класа у m/god.

11. **Табела 2 Алтернативни формат класа брзина померања клизишта**

Класа	**Опис**	**Брзина**	**mm/sec**
7	**Екстремно брзо**		
	-------- -------------------	5m/sec	5×10^3
6	**Врло брзо**		

	-------- -------------------	3m/minute	50
5	**Брзо**		
	-------- -------------------	1.8m/hr	0.5
4	**Умерено**		
	-------- -------------------	3m/week	5×10^{-3}
3	**Споро**		
	-------- -------------------	1.6m/year	50×10^{-6}
2	**Врло споро**		
	-------- -------------------	16mm/year	0.5×10^{-6}
1	**Екстремно споро**		

Брзине у табели представљају границе између класа

Appendix B: Nomenclature: Water Conditions

Water Condition

Water Content

Varnes (1978) gave a four-part observational division of "water content" in material in landslides. This was applied by Cruden and Varnes (1996) to displaced material in landslides. In fine-grained soils, the boundaries between the terms were considered to correspond approximately with Atterberg Limits, with the Shrinkage, Plastic and Liquid Limits separating dry, moist, wet and saturated soils respectively (Cruden and Couture, 2011).

Table 1: Boundaries between states according to water condition for fine-grained soils

Water condition	Consistency Index *	Liquidity Index *	Limit water contents **
Dry	$I_C > 1.25$	$I_L < -0.25$	Water content at the shrinkage limit (5-15%)
Moist	$1.0 < I_C < 1.25$	$-0.25 < I_L < 0$	Water content at the plasticity limit (15-30%)
Wet	$0 < I_C < 1$	$0 < I_L < 1$	Water content at the liquidity limit (40-60%)
Saturated	$I_C < 0$	$I_L > 1$	

*These values are determined on samples from the displaced material
**These values are can vary depending on the dominant type of clay mineral

The terms Frozen and Thawed were added by Cruden and Couture (2011) to describe the water condition in displaced material in permafrost terrains and prompted a change from use of the term "water content" to " water condition" in the Canadian Guidelines (Cruden and Van Dine, 2013).

Water Condition

Assessment of the Water Condition of displaced landslide material should be made in the field. It is important that the terms lend themselves to a judgement of the overarching Water Condition of the displaced mass, and its role in landslide movement (trigger, ongoing movement, renewed movement), and not rely on subsequent laboratory-based testing of displaced soil samples.
There are two key aspects that need to be considered:

- The displaced mass, and
- The position of the water table in relation to the failure surface prior to failure (if this can be determined).

A. Displaced Mass

The water condition of the displaced mass can be described for all landslides. We propose a qualitative description based on field judgement but aligned with the water content for fine grained soils as set out in Table 2. It is proposed that displaced mass water condition be denoted by an upper case letter.
Alternative descriptors are provided for displaced masses in colder environments where water may freeze and thaw (after Cruden and Van Dine, 2013), and for geothermal environments where steam has been a contributing factor to the alteration, weakening and failure of the materials. The replacement of steam with water of increases the weight and pore pressures in the displaced material, making further, subsequent failures more likely as geothermal activity wanes and migrates.

Table 2: Proposed Water Condition Descriptors

Water Condition	Description	% Water Making up Displaced Material	Illustration
Dry (D)	No moisture visible	<5 %	
Moist (M)	No free water	5 – 30%	
Wet (W)	The material behaves in part as a liquid, with water flowing from it, and/ or supporting bodies of standing water	30 – 50%	
Fluidised (Fl)	The material flows as a liquid, discharging water	>50%	
Water Condition in cold climates			
Frozen (Fr)	Water is present as ice		
Thawed (T)	Much of the water is in a liquid phase but some ice may still be present		
Water Condition in geothermal environments			

Steam (St)	The ground is warm and much or all of the water is present as steam.	

B. Water Condition of the Failure Plane
A further consideration is the position of the groundwater table in relation to the failure surface prior to failure, *where this can be determined* from field observations investigations. It is proposed that these are denoted by a lower case letter.

Water Condition	**Failure Plane Water Condition**	**Illustration**
Dry (d)	No moisture visible	
Moist (m)	No free water	
Wet (w)	Water perched on failure plane	
Saturated (s)	Groundwater level above the failure plane	

References:
Cruden, D.M., Couture, R., 2011: The Working Classification of Landslides: Material Matters, Proceedings, 64th Canadian Geotechnical Conference, Toronto, Paper 1106

Cruden, D.M., Van Dine, D.F., 2013: Classification, Description, Causes and Indirect Effects - Canadian Technical Guidelines & Best Practices Related to Landslides. Geological Survey of Canada, Open File 7359

Cruden, D.M., Varnes, D.J., 1996: Chapter 3, Transportation Research Board, National Academy of Sciences, Special Report 247

Varnes, D.J., 1978: Chapter 2, Transportation Research Board, National Research Council, Special Report 176

Appendix C: Nomenclature: Types of Material

Types of Material

Varnes (1978) gave a two-part observational division of "material" in landslides: bedrock and engineering soil. It was to be applied to the material before displacement. Engineering soil, then, was divided into "debris" which contained a significant proportion of coarse material and "earth" in which more than 80% of the fragments are smaller than 2mm. "This division of material that is completely gradational is admittedly crude; however, it is intended mainly to enable a name to be applied to material ... on the basis of a limited amount of information", Varnes (1978, p.24). WP/WLI (1990) simplified this terminology to rock, debris and earth though it was obvious that more elaborate schemes were possible; Varnes (1978, Figures 2.24, 2.25, 2.26) had already pictured dry sand and silt flows. With the adoption of an International Standard (ISO 14688-1), earths could be divided into cohesionless (coarse) and cohesive (fine) soils. Further subdivision into silts and clays is made possible by simple field tests (Cruden and Couture, 2011) for uniform soils, producing a classification of soil into debris, sand, silt or clay.

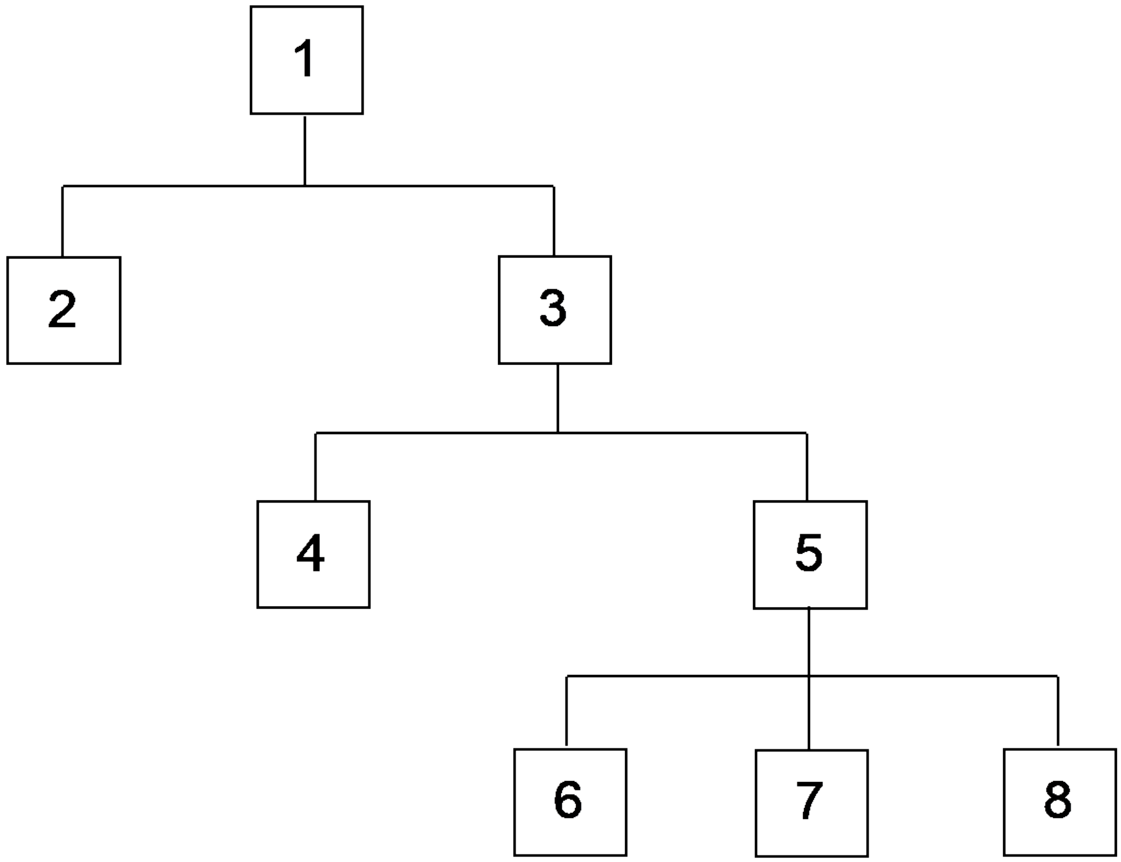
References:

Cruden, D.M., Couture, R., 2011, The Working Classification of Landslides: Material Matters, Proceedings, 64th. Canadian Geotechnical Conference, Toronto, Paper 1106

International Organization for Standardization, 2002, Geotechnical Investigation and Testing:Identification and Classification of Soil: Part 1: Identification and Description ISO 14688-1, 12p

Varnes, D.J.,1978, Chapter 2, Transportation Research Board, National Research Council, Special Report 176

WP/WLI,1990, A Suggested Method for Reporting a Landslide, Bulletin IAEG, 41:5-12


1
2
3
4
5
6
7
8

1. **Material**

2. **Rock: Natural aggregate of minerals that cannot be readily broken by hand and that will not disintegrate on a first wetting and drying cycle.**

3. **Soil: Aggregate of solid minerals and rocks that is either fragmentary or can be readily separated by agitation in water.**

4. **Debris: 20% to 80% of the particles larger than 2 mm.**

5. **Earth: 80% or more of the particles smaller than 2 mm.**

6. **Sand: Earth fraction larger than 0.063 mm.**

7. **Silt: Earth fraction smaller than 0.063 mm and larger than 0.002 mm.**

8. **Clay: Earth fraction smaller than 0.002 mm.**

Appendix D: Nomenclature: Landslide Risk

English

Terms	Definition	side comments (to be included in the accompanying text)
Acceptable risk	A risk that society is prepared to accept. Action to further reduce such risk is usually not likely to be required.	
ALARP (As Low As Reasonably Practicable) principle	This principle which states that risks, higher than the limit of acceptability, are tolerable only if risk reduction is impracticable or if its cost is grossly in disproportion (depending on the level of risk) to the improvement gained.	
Conditional probability	The probability of an outcome, given the occurrence of some event.	
Consequence	In the context of risk analysis, the outcome or result of a hazard being realized.	
Countermeasure	Any measures taken to counter and reduce risk.	They most commonly refer to engineering (structural) measures but can also include other non-structural measures and tools designed and employed to avoid or limit the adverse impact of natural hazards and related environmental and technological consequences.

Danger (Threat)	The natural phenomenon that could lead to damage, described in terms of its geometry, mechanical and other characteristics.	The danger can be an existing one (such as a creeping slope) or a potential one (such as a menacing block). The characterisation of a danger or threat does not include any forecasting.
Element at risk	Population, buildings and engineering works, infrastructure, environmental features, cultural values and economic activities in the area potentially affected by an event (e.g. landslide).	
Environmental risk	(a) The potential for an adverse effect on the natural system (environment); (b) the probability of suffering damage because of exposure to some environmental circumstance.	
Event	The realisation of a hazard	
Exposure	People, property, systems, or other elements present in hazard zones that are thereby exposed to potential losses.	
Extreme event	Event, which has a very low annual exceedance probability (AEP).	
Failure	A fracturing or giving way under stress	
Fault tree analysis	A system engineering method for representing the logical combination of various system states and possible causes, which can contribute to a specified problematic (fault) event (called the top event).	

Forecast	Definite statement or statistical estimate of the likely occurrence of a future event or conditions for a specific area.	
f, N pairs	Refers to "f', the probability of life loss due to failure for each scenario studied, and "N", the number of lives expected to be lost in the event of such a failure scenario.	The term "N" can be replaced by any other quantitative measure of failure consequences, such as monetary measures.
F-N curves	Curve relating the probability per year of causing N or more fatalities (F) to N.	This is the complementary cumulative distribution function. Such curves may be used to express societal risk criteria and to describe the safety levels of particular facilities.
Fragility curve	Defines the probability of failure of a structure as a function of an applied load level.	
Hazard	A condition with the potential of causing an undesirable consequence. Mathematically, the probability of a particular threat occurring in an area within a defined time period	
Hazard level	A measure of the intensity and probability of occurrence of a hazardous event.	
Hazard matrix	tool for ranking and displaying hazard by defining ranges for landslide intensity (magnitude) and likelihood	

Hazard zonation	Mapping of an area in which particular zones correspond to different hazard levels.	Often used as a basis for landuse planning (see also landslide hazard maps).
Individual risk to life	The increment of risk imposed on a particular individual by the existence of a hazard.	This increment of risk is an addition to the background risk to life, which the person would live with on a daily basis if the hazard did not exist.
Involuntary risk	A risk imposed on people by a controlling body and not assumed by free choice of the people at risk.	
Landslide inventory	A record of recognized landslides in a particular area.	The landslides can be distinguished by typology, geometry and activity.
Landslide hazard analysis	The use of available information to estimate the zones where landslides of a particular type, volume, intensity and runout may occur within a given period of time.	
Landslide hazard map	A map in which different areas are related to particular landslide hazard level.	
Landslide intensity	A set of spatially distributed parameters related to the destructive potential of a landslide.	The parameters may be described quantitatively or qualitatively and may include maximum movement velocity, total displacement, differential displacement, depth of the moving mass, peak discharge per unit width, kinetic energy per unit area.

Landslide magnitude	The measure of the landslide size.	It may be quantitatively described by its volume or, indirectly by its area. The latter descriptors may refer to the landslide scar, the landslide deposit or both, but this must be specified.
Landslide probability	In the framework of landslide hazard assessment the following types of probability are of importance: (i) spatial probability: the probability of occurrence of a landslide in a given area. (ii) temporal probability: the probability that a landslide will occur in a given period of time in a specified area. (iii) size/volume probability: probability that any given landslide has a specified size/volume. (iv) runout probability: probability that any given slide will reach a specified distance or affect a specified area downslope.	
Landslide risk map	The subdivision of the terrain in zones that are characterized by different probabilities of losses (physical,societal, economic, environmental) that might occur due to landslides of a given type within a given period of time.	The risk may be indicated either qualitatively (as high, moderate, low and no risk) or quantitatively (in numbers or economic values).

Landslide susceptibility	A quantitative or qualitative assessment of the volume (or area) and spatial distribution of landslides**,** which exist or potentially may occur in an area. Susceptibility may also include a description of the velocity and intensity of the existing or potential landsliding.	
Landslide susceptibility map	A map showing the subdivision of the terrain in zones that have a different likelihood that landslides of a given type may occur.	
Mitigation	Measures undertaken to limit the adverse impact of, for instance, natural hazards, environmental degradation and technological hazards.	
Phase of Landslide activity	The stage of development of a landslide	pre-failure when the slope is strained throughout but is essentially intact; failure characterized by the formation of a continuous surface of rupture; post-failure which includes movement from just after failure to when it essentially stops; and reactivation when the slope slides along one or several pre-existing surfaces of rupture. Reactivation may be occasional (e.g. seasonal) or continuous (in which case the slide is "active").
Population at risk	All the persons who would be directly exposed to the consequences of landslides.	

Preparedness	Activities and measures taken in advance to attempt effective response to hazards and their consequences.	
Prevention	The avoidance of adverse impacts (consequences).	
Recurrence interval	The recurrence interval, or return period, is the long-term average elapsed time between landslide events at a particular site or in a specified area.	
Residual risk	The remaining level of risk after a program of risk mitigation has been implemented.	
Retroffitting	Reinforcement or upgrading of existing structures to become more resistant and resilient to the damaging effects of hazards.	
Risk	Measure of the probability and severity of an adverse effect to life, health, property, or the environment. Quantitatively, Risk = Hazard xPotential Worth of Loss.	This can be also expressed as "Probability of an adverse event times the consequences if the event occurs".
Risk analysis	The use of available information to estimate the risk to individuals or populations, property or the environment, from hazards.	Risk analyses generally contain the following steps: definition of scope, danger (threat) identification, estimation of probability of occurrence to estimate hazard, evaluation of the vulnerability of the element(s) at risk, consequence analysis, and their integration.

Qualitative risk analysis	An analysis which uses verbal or relative rating scales to describe the magnitude of potential consequences and the likelihood that those consequences will occur.	
Quantitative risk analysis	An analysis based on numerical values of the probability of occurrence of a potentially damaging event, vulnerability of the exposed elements and consequences, and resulting in a numerical value of the risk.	
Reach probability	see runout probability	
Risk assessment	The process of making a recommendation on whether existing risks are acceptable and present risk control measures are adequate, and if not, whether alternative risk control measures are justified or will be implemented.	Risk assessment incorporates the risk analysis and risk evaluation phases.
Risk control	The implementation and enforcement of actions to control risk, and the periodic re-evaluation of the effectiveness of these actions.	
Risk evaluation	The stage at which values and judgement enter the decision process, explicitly or implicitly, by including consideration of the importance of the estimated risks and the associated social, environmental, and economic consequences, in order to identify a range of alternatives for managing the risks.	

Risk management	The systematic application of policies, procedures and practices to the tasks of identifying, analysing, assessing, monitoring and mitigating risk.	
Risk mitigation	Application of appropriate techniques and principles to reduce either probability of an occurrence or its adverse consequences, or both.	
Runout probability	Probability that a specified landslide will reach a certain distance downslope or affect a specified area.	
Scenario	A single realization of the consequences of a given event (or a sequence of events) having a given probability of occurrence.	
Societal risk	The cumulative estimated risk to all individuals exposed to a landslide hazard within the consultation zone.	
Susceptibility	See Landslide susceptibility.	
Spatio-temporal probability of the element at risk	The probability that the element at risk is in the landslide path at the time of its occurrence. It is the quantitative expression of the exposure.	
Tolerable risk	A risk within a range that society can live with so as to secure certain net benefits.	It is a range of risk regarded as non-negligible and needing to be kept under review and reduced further if possible.
Voluntary risk	A risk that a person faces voluntarily in order to gain some benefit.	

Vulnerability	The degree of loss of a given element or set of elements exposed to the occurrence of a landslide of a given magnitude/intensity.	It is often expressed on a scale of 0 (no loss) to 1 (total loss).
Zonation	The division of land into homogeneous areas or domains and their ranking according to degrees of actual or potential landslide susceptibility, hazard or risk.	

Chinese

名词	定义	注释
可接受风险	确定可接受的风险，且不需要采用其他手段来降低风险值。	
ALARP 原则（最低合理可行原则）	这一原则指，只有在降低风险需要采取的措施并不实际或者在防止风险的成本和其效益严重不成比例时（和风险水平有关），允许不去避免此风险。	
条件概率	条件概率是指某事件在另外一个事件已经发生条件下的发生概率。	
灾情	在风险分析过程中，灾害发生所导致的后果。	
对策	为防范风险发生采取的措施。	通常指工程（或结构）措施，也包括采用其他非结构措施和手段来避免或降低自然灾害带来的负面影响及相关的对环境和技术方面的影响。
危险（威胁）	从几何、力学和其他特征角度描述的，可能导致毁坏的自然现象。	危险可以是已经存在的（如蠕滑）或者潜在的（如有危险性块体）。不可能预报危险或者威胁。
风险个体	受到潜在威胁（如滑坡）的区域内的居民、楼房、工程建筑物、基础设施、环境特性、文化价值观、以及经济活动。	
环境风险	（a）对自然系统（环境）产生不利影响的可能性（b）由于暴	

	露在某些环境中而遭受损害的概率	
事件	对灾害发生的认识。	
暴露	在危险区域中，面临潜在的损失的人员、财产、系统或者其他单元体。	
极端事件	年超越概率非常低的事件。	
破坏	压力下发生破裂或失去控制。	
故障树分析法	是一种系统工程方法，有助于在特定的问题或（错误）事件中明确各种系统状态的逻辑关系和可能的原因。	
预报	对一特定区域内，某一未来事件可能发生的情况的明确陈述或统计估计。	
f,N 组合	“f”指得是每一个研究方案中，由于发生破坏而导致死亡的概率;“N”指在上述事件中，死亡人数的估计。	“N”也可以选用其它能够定量反映灾害影响的参数来表示，如采取货币措施。
F,N 曲线	导致 N 个死亡或者更多死亡（F）年概率的曲线	这是一个互补累计分布函数，可以用来表述社会风险标准以及特定设施的安全等级
易损性曲线	定义结构破坏的概率是关于荷载水平的函数。	
致灾因子	一种有可能导致不良后果的情况。从数学角度上说，指在一定时间内发生特定危险的概率。	
灾害等级	用来描述灾害发生强度和发生概率的方法。	
风险矩阵	通过定义滑坡强度（量级）的范围对灾害进行排序和表征的一种工具。	
灾害区划	根据不同的灾害等级进行的地域划分。	经常被用作土地使用规划的基础（参考滑坡灾害图）
个体生存性风险	由于灾害导致特定个人的风险增加。	这种风险是在其他生存风险之外，如果灾害没有发生，那么不会影响到人们的正常生活。
非自愿性风险	是强加给人的风险，不能够由人自由选择。	
滑坡编录	记录在某一特定地区发生的山体滑坡	可以用滑坡类型、几何特征以及活跃度区分滑坡。
滑坡灾害分析	在给定的一段时间内，利用掌握的资料，依据滑坡的类型、体积、强度以及滑距对滑坡进行划分。	
滑坡灾害图	在地图上用不同的区域对应不同的滑坡灾害等级。	

滑坡强度	和潜在破坏程度有关的一组滑坡空间分布的参数。	可以用定量或者定性的方法描述，包括了最大滑动速度、总位移、差异位移、滑体深度、单位宽度峰值流量、单位面积动能。
滑坡量级	测量滑坡的规模。	可以用体积或者间接用面积来定量描述。后者可以是滑坡后壁、滑坡体或者两个的组合，但是必须要指明。
滑坡概率	在滑坡灾害评价当中，下列几种概率是非常重要的： **1. 空间概率：在一个区域内发生滑坡的概率。** **2. 时间概率：在一个区域内，一个给定时间段内发生滑坡的概率。** **3. 大小/体积概率：存在任意滑坡达到一定大小/体积的概率。** **4. 滑距概率：存在任意滑坡的滑距达到一定值的概率。**	
滑坡风险图	一段特定时间，依据区域内某一类滑造成的损失概率（物质，社会，经济，环境）对地形进行划分。	可以用定性（高风险、中风险、低风险、无风险）或者定量（数值或者经济指标）的方法。
滑坡易发性	在一个区域内，定量或者定性的评估可能发生滑坡的体积和空间分布规律。易发性还包括对现有或者潜在滑坡的滑坡速度、强度的描述。	
滑坡易发性评价图	在地图上划分不同区域，用来代表可能发生的一类滑坡。	
治理	采取措施来限制如自然灾害、环境退化、技术危害带来的不利影响。	
滑坡活动期	滑坡的发展阶段	斜坡在前破坏阶段仍然是完整的；在破坏阶段出现连续的坡面断裂；而破坏后包括的时间段由破坏刚刚发生到滑动停止；滑坡复活指的是斜坡沿着一个或者多个现有的破坏面滑

		动。滑坡复活可以是偶发的（季节性）或者是连续的（滑坡是活跃的）。
受害人群	滑坡直接波及的人群	
防备	针对灾害及其后果提前采取活动或者措施。	
防治	避免灾害的不利影响（后果）	
重复周期	复发的间隔或者重现期是指在某一特定地点或某一特定区域的滑坡事件之间的长期平均间隔时间。	
残余风险	项目风险消减实施后的剩余风险水平。	
改进	对现有结构进行加固或升级，使其对灾害的破坏性具有更强的抵抗力和可恢复性。	
风险	用来量度对生命、健康、财产或环境带来不利影响的概率和严重程度。定量来讲，风险=致灾因子*潜在损失。	这也可以表示为“不利事件发生的概率乘以事件发生的后果”。
风险分析	以现有的资料估计个人或集体、财产或环境受到灾害影响的风险。	风险分析一般包括以下步骤:范围的定义、危险(威胁)识别、估计灾害的发生概率、风险个体脆弱性评估、结果分析和上述集合。
定性风险分析	一种使用口头或相对等级来描述潜在的后果量级以及造成这些后果的可能性。	
定量风险分析	一种基于潜在破坏性事件发生概率、暴露个体的脆弱性和灾害后果的风险数值分析。	
到达概率	参见滑距概率	
风险评估	对现有的风险是否可接受以及现有的风险控制措施是否充分提出建议的过程，如若不然，是否调整采取其他风险控制措施。	风险评估包括风险分析和风险评估阶段。
风险控制	为了控制风险实施并采取必要行动，以及定期对这些行动的有效性重新评估。	
风险评价	为了确定风险管理的方案，考虑风险评价的重要性以及相关的社会、环境和经济后果，明确或含蓄地将价值和判断纳入决策的过程。	
风险管理	系统的运用政策、过程和实践进行灾害风险识别、分析、评估、监测和风险治理。	
风险治理	采取适当技术和原则减少风险发生的概率或不利结果，或能够同时减少以上二者。	

滑距概率	指定滑坡能够到达一定的下坡距离或影响指定区域的概率。	
情节	独立的意识到具有确定发生概率事件(或一系列事件)带来的后果。	
社会风险	一个区域内受滑坡灾害影响的所有个体的累积估计风险。	
易发性	参见滑坡易发性	
风险个体的时空概率	滑坡发生时，风险个体在滑坡路径中的概率。是一种定量表达暴露在风险中的方法。	
可容许风险	为了获得一定净收益的，属于社会可以承受的范围内的风险。	这是一个范围性风险，不能够忽略且需要经常检查，可能的话需要进一步降低。
自愿承担风险	某人为了获得某种利益而自愿面对的风险。	
易损性	在发生某一量级/强度的滑坡时，某一特定单元或一组单元的损失程度。	通常用尺度 0（无损失）到 1（全部损失）来表示。
分区	把土地划分成均匀的区域，并根据实际或潜在滑坡的易发性、灾害或风险的程度对其进行排序。	

Spanish

Término	Spanish Definición
Riesgo aceptable	Riesgo que una sociedad está dispuesta a aceptar. No es probable que se requieran medidas adicionales de reducción del riesgo.
Principio del mínimo razonablemente viable	Principio que establece que los riesgos que superan el límite de aceptabilidad, son tolerables si su reducción es inviable o coste desproporcionado (dependiendo del nivel de riesgo) en relación a la mejora obtenida.
Probabilidad condicional	La probabilidad de un resultado dada la ocurrencia de un evento
Consecuencia	En el contexto del análisis del riesgo, la consumación de una amenaza
Medida paliativa	Cualquier medida adoptada para reducir el riesgo
Peligro (Amenaza)	Cualquier fenómeno natural que pueda traducirse en un daño, descrito en términos de sus características geométricas, mecánicas u otras.
Elemento en riesgo	Población, edificios, obras de ingeniería, infraestructuras, elementos ambientales, valores culturales y actividades económicas presentes en el área potencialmente afectada por un evento (p.e. deslizamiento)
Riesgo ambiental	(a) el potencial de un efecto adverso sobre el sistema natural (medio ambiente); (b) la probabilidad de sufir un daño debido a la exposición a una circunstancia del entorno natural.
Evento	La consumación de la amenaza

Exposición	Personas, propiedades, sistemas u otros elementos presentes en las zonas amenazadas, que por lo tanto están sujetas a pérdidas potenciales.
Evento extremo	Evento que tiene una muy baja probabilidad anual de ocurrencia
Rotura	Fractura o desplazamiento bajo tensión
Análisis de árbol de fallos	Un método de ingeniería de sistemas para representar la combinación lógica de varios estados del sistema y posibles causas, que den lugar a un evento problemático específico (fallo) , llamado evento superior.
Pronóstico	Afirmación explícita o estimación estadística de la probable ocurrencia de un futuro evento o de las condiciones en un área específica
pares f,N	Para cada escenario estudiado, "f" es la probabilidad de la pérdida de vida debido a una rotura y "N" el número de vidas que pueden perderse en el citado escenario
curva F-N	Curva que relaciona la probabilidad anual (F) de causar N o más muertes respecto a N.
Curva de fragilidad	Define la probabilidad de rotura de una estructura en función del nivel de carga aplicado
Peligro (South America: **Amenaza**)	Una condición con el potencial de causar una consecuencia no deseada. Matemáticamente, la probabilidad que una amenaza particular ocurra en un área durante un periodo de tiempo definido
Nivel de peligro (South America: **Nivel de amenaza**)	Medida de la intensidad y probabilidad de ocurrencia de un evento peligroso

Matriz de Peligrosidad (South America: Matriz **de amenaza**)	Herramienta para jerarquizar y representar el peligro a partir de la definición de ragos de la intensidad del deslizamiento (magnitud) y la probabilidad
Zonación de la peligrosidad	Mapeo de un área en la que cada zona particular corresponde a un nivel de peligro (amenaza) diferente
Riesgo individual de pérdida de vida	El incremento del nivel de riesgo que la existencia de una amenaza impone sobre un individuo particular
Riesgo involuntario	Riesgo que un elemento somete a la población y no es asumido libremente por la misma
Inventario de deslizamientos	Registro de los deslizamientos identificados en una región
Análisis de la peligrosidad (amenaza) por deslizamientos	Usi de la información disponible para estimar las zonas donde pueden ocurrir deslizamientos de un determinado tipo, volumen, intensidad y alcance, en un periodo de tiempo dado
Mapa de peligrosidad por deslizamientos	Mapa en el que las diferentes áres tienen asociado un nivel de peligro (amenaza) concreto
Intensidad del deslizamiento	Conjunto de parámetros distribuidos espacialmente que tienen relación con el poder destructivo del deslizamiento
Magnitud del deslizamiento	Medida del tamaño del deslizamiento

Probabilidad de deslizamiento	En el marco de la evaluación del peligro (amenaza) por deslizamientos, son importantes los siguientes tipos de probabilidad: (i) probabilidad espacial: probabilidad de ocurrencia de un deslizamient en un área dada (ii) probabilidad temporal: probabilidad que un deslizamiento tenga lugar en una are y periodo de tiempo determinado (iii) probabilidad de un tamaño o volumen: probabilidad de que un deslizamiento tenga una tamño o volumen determinado (iv) probabilidad de alcance: probabilidad que un deslizamiento alcance una distancia especificada ladera abajo o que afecte una una determinada área
Mapa de riesgo por deslizamiento	Subdivisión del territorio en zonas caracterizadas por diferentes probabilidades de pérdidas (físicas, sociales, económicas, ambientales) que pueden darse como resultado de deslizamientos de un determinado tipo y en un periodo de tiempo dado.
Susceptibilidad al deslizamiento	Evaluación cualitativa o cuantitativa de la distribución espacial y volumen (o área) de los deslizamientos que existen o puedan ocurrir en un área dada. La susceptibilidad puede incluir también la descripción de la velocidad e intensidad de los deslizamientos existentes o potenciales
Mapa de susceptibilidad al deslizamiento	Mapa que muestra la subdivisión de territorio en zonas con distinta probabilidad de ocurrencia de deslizamiento de un determinado tipo
Mitigación	Medidas adoptadas para limitar el impacto adverso de, por ejemplo, peligros naturales, degradación ambiental y peligros tecnológicos
Fase de actividad del deslizamiento	Estadio de desarrollo de un deslizamiento

Población amenazada	Todas las personas que se verían expuestas directamente a las consecuencias de los deslizamientos
Preparación	Actividades y medidas adoptadas con antelación para dar respuesta efectiva a las amenazas y sus consecuencias
Prevención	Elusión de los impactos adversos (consecuencias)
Periodo de retorno	El tiempo promedio a largo plazo entre eventos de deslizamiento en un lugar o área determinada
Riesgo residual	El nivel de riesgo remanente después de la implementación de medidas de mitigación del riesgo
Readaptación	Refuerzo o reacondicionamiento de las estructuras existentes para que sean más resistentes y resilientes a los efectos dañinos de los peligros naturales
Riesgo	Medida de la probabilidad y severidad de un efcto adverso para la vida, salud, propiedades y el medio ambiente. Cuantitativamente, riesgo =PeligroxPérdida Potencial
Análisis del riesgo	Uso de la información disponible para estimar el riesgo para personas o la población, propiedades o el medio ambiente por los peligros (amenazas)
Análisis cualitativo del riesgo	Análisis que utiliza una escala de jerarquización relativa o verbal para describir la magnitud de las consecuencias potenciales y su probabilidad de ocurrencia

Análisis cuantitativo del riesgo	Análisis que utiliza valores numéricos de la probabilidad de ocurrencia de un evento potencialmente destructivo, la vulnerabilidad de los elementos amenazados y las consecuencias y que da como resultado un valor numérico del riesgo
Probabilidad de alcance	
Estimación del riesgo	Proceso de generar recomendaciones sobre si el riesgo existente es aceptable y si las medidas existentes de control son adecuadas. En caso contrario, si se justifican medidas de control alternativas o si deben ser implementadas
Control del riesgo	Implementación y aplicación de medidas para controlar el riesgo y reevaluación peródica de su efectividad
Evaluación del riesgo	Estadio en el que las valoraciones y el criterio entran en el proceso de decisión ya sea de forma explícita o implícita icluyendo la consideración de la importancia del riesgo estimado y de las consecuencias sociales, ambientales y económicas asociadas, de cara a identificar un abanico de alternativas para gestionar el riesgo
Gestión del riesgo	Aplicación sistemática de politicas, procedimientos y prácticas en las tareas de identificación, análisis, evaluación, seguimiento y mitigación del riesgo
Mitigación del riesgo	Aplicación de las técnicas y principios apropiados para reducir ya sea la probabilidad de ocurrencia de un evento, de sus consecuencias adversas o de ambas
Probabilidad de alcance	Probabilidad que un deslizamiento alcance una cierta distancia ladera abajo o afecte una ára derterminada

Escenario	La manifestación de las consecuencias de un determinado evento (o una secuenca de eventos) que tiene una probabilidad de ocurrencia dada
Riesgo social	Riesgo acumulado estimado de todos los individuos amenazados por deslizamientos en la zona objeto de análisis
Susceptibilidad	ver susceptibilidad al deslizamiento
Probabilidad espacio-temporal del elemento amenazado	Probabilidad que un elemento amenazado se encuentre en la trayectoria del deslizamiento en el momento de su ocurrencia. Es la expresión cuantitativa de la exposición
Riesgo tolerable	Riesgo situado detrno de un rango con el que la sociedad puede convivir, con tal de obtener ciertos benecicios
Riesgo voluntario	Riesgo que una persona asume voluntariamente con tal de obtener algún beneficio
Vulnerabilidad	Grado de pérdida de un elemento o conjunto de elementos determinados expuestos la ocurrencia de un delsizamiento de magnitud/intensidad dada
Zonificación	La división del territorio en area o domínios homogéneos y su jerarquización de acuerdo vcon el grado actual o potencia de susceptibilidad, peligrosidad (amenaza), o riesgo por deslizamientos

Romanian

Termeni	Definitie
Risc acceptabil	Riscul pe care societatea este pregatită sa îl accepte. Acțiunea de a reduce un astfel de risc nu este de obicei solicitată.
Principiul ALARP (As Low As Reasonably Practicable)	Acest principiu, care statuează că riscurile mai mari decât limita de acceptabilitate sunt tolerabile, numai dacă reducerea riscului este impracticabilă sau dacă costurile sunt disproporționat de mari (depinzând de nivelul riscului) în raport cu ameliorarea care se poate obține.
Probabilitate condițională	Probabilitatea unui rezultat, având în vedere apariția unor evenimente.
Consecința	În contextul analizei riscurilor, urmarea sau rezultatul unui hazard realizat.
Contramăsuri	Orice măsuri luate pentru a contracara și a reduce riscul
Pericol (amenințare)	Fenomenul natural care poate conduce la daune, descis în termenii geometriei, mecanicii sau altor caracteristici ale sale.
Elemente la risc	Populația, clădirile și lucrările inginerești, infrastructura, caracteristicile ambientale, valorile culturale și activitățile economice din aria potențial afectată de un eveniment (e.g. alunecare de teren)
Eveniment	Realizarea unui hazard
Expunere	Populația, proprietățile, sistemele sau alte elemente prezente în zone de hazard care sunt in consecință expuse la pierderi potențiale
Eveniment extrem	Eveniment care are o foarte mică probabilitate anuală de depășire (AEP)
Rupere	O fracturare sau cedare la efort

Analiza FTP (Fault Tree Analysis)	O metodă inginerească de sistem pentru reprezentarea combinației logice a unor stări de sistem variate și cauze posibile, care pot contribui la un eveniment problematic specific (numit eveniment de top)
Prognoza	Definirea precisă sau estimarea statistică a producerii probabile a unui viitor eveniment sau a condițiilor de producere pentru o arie specifică.
Perechile f, N	Se referă la "f", probabilitatea pierderii de vieți omenești din cauza evenimentului pentru fiecare scenariu studiat și "N", numărul de vieți așteptate să se piardă în cazul unui astfel de scenariu de eveniment.
Curbele F-N	Curbe reprezentând probabilitatea de a produce N sau mai multe decese (F) în funcție de N.
Curba de fragilitate	Definește probabilitatea de rupere a unei structuri ca o funcție a nivelului de încărcare aplicat.
Hazard	Un eveniment cu potențial de a provoca o consecință nedorită. Din punct de vedere matematic, probabilitatea unei amenințări particulare care apare într-o zonă într-o perioadă de timp definită.
Nivelul hazardului	O măsură a intensității si probabilității de producere a unui fenomen de hazard.
Matricea de hazard	Instrument pentru clasificarea și reprezentarea hazardului prin definirea intervalelor de intensitate a alunecărilor de teren (magnitudinea) și de probabilitate.
Zonarea hazardului	Cartografierea unei arii în care zonele particulare corespund unor niveluri de hazard diferite.
Riscul de viață individual	Creșterea riscului impus unei persoane particulare de producerea unui hazard
Riscul involuntar	

	Un risc impus persoanelor de către un organism de control și care nu este asumat de libera alegere a persoanelor expuse riscului.
Inventarul alunecărilor de teren	O înregistrare a alunecărilor de teren recunoscute într-o anumită zonă.
Analiza hazardului la alunecări de teren	Utilizarea informațiilor disponibile pentru estimarea zonelor în care pot apărea alunecări de teren de un anumit tip, volum, intensitate și distanță de deplasare într-o anumită perioadă de timp.
Harta de hazard la alunecări de teren	O hartă în care zone diferite sunt raportate la niveluri particulare de hazard la alunecări de teren.
Intensitatea alunecărilor de teren	Un set de parametri distribuiți spațial raportați la potențialul distructiv al unei alunecări de teren.
Magnitudinea alunecărilor de teren	Măsura mărimii unei alunecări de teren
Probabilitatea unei alunecări de teren	In cadrul evaluării hazardului la alunecări de teren sunt importante următoarele tipuri de probabilități: (i) probabilitatea spațială: probabilitatea de producere a unei alunecări de teren într-o arie dată. (ii) probabilitatea temporală: probabilitatea ca o alunecare de teren să se producă într-o anumită perioadă de timp într-o arie specificată. (iii) probabilitatea mărimii/volumului: probabilitatea ca o anumită alunecare de teren să aibă o mărime/volum specificate. (iv) probabilitatea deplasării: probabilitatea ca o alunecare de teren dată să atingă o anumită distanță de deplasare sau să afecteze un versant pe o anumită arie.
Harta de risc la alunecări de teren	Subdiviziunea terenului în zone care se caracterizează prin diferite probabilități de pierderi (fizice, societale, economice, de mediu) care ar putea apărea din cauza alunecărilor de teren de un anumit tip într-o anumită perioadă de timp.

Susceptibilitatea la alunecări de teren	Evaluarea cantitativă sau calitativă a volumului (sau a suprafeței) și a distribuției spațiale a alunecărilor de teren, care există sau ar putea să apară într-o zonă. Susceptibilitatea poate include, de asemenea, o descriere a vitezei și intensității alunecărilor de teren existente sau potențiale.
Harta de susceptibilitate la alunecări de teren	O hartă care prezintă subdiviziunea terenului în zone cu diferite probabilitați de producere a unor alunecări de teren de un anumit tip.
Reducerea riscului	Măsuri luate pentru a limita impactul negativ, de exemplu, asupra hazardurilor naturale, degradării mediului și a riscurilor tehnologice.
Faza de activitate a unei alunecări de teren	Stagiul de dezvoltare a unei alunecări de teren.
Populația supusă riscului	Toate persoanele care ar fi direct expuse la consecințele unei alunecări de teren.
Starea de pregătire	Activități și măsuri luate în avans pentru a testa reacția eficientă la pericole și consecințele acestora.
Prevenirea	Evitarea efectelor negative (consecințelor).
Intervalul de recurență	Intervalul de recurență sau perioada de revenire reprezintă timpul mediu scurs între evenimentele de alunecări de teren dintr-un anumită zonă sau într-o arie specificată.
Riscul rezidual	Nivelul de risc rămas după implementarea unui program de atenuare a riscurilor.
Retehnologizarea	Armarea sau actualizarea structurilor existente pentru a deveni mai rezistente și adaptate la efectele dăunătoare ale hazardurilor.
Riscul	Măsurarea probabilității și gravității unui efect advers asupra vieții, sănătății, proprietății sau mediului. Cantitativ, Risc = Hazard x Valoarea potențială a pierderilor. Măsurarea probabilității și gravității unui efect advers

asupra vieții, sănătății, proprietății sau mediului. Cantitate, Risc = Risc x Valoarea potențială a pierderii.

Analiza riscului	Utilizarea informațiilor disponibile pentru a estima riscurile pentru persoane sau populații, proprietăți sau mediu, provocate de hazarduri. Utilizarea informațiilor disponibile pentru a estima riscurile pentru persoane sau populații, bunuri sau mediu, de la pericole. "
Analiza calitativă a riscului	O analiză care utilizează scări de evaluare verbală sau relativă pentru a descrie amploarea consecințelor potențiale și probabilitatea ca aceste consecințe să aibă loc.
Analiza cantitativă a riscului	O analiză bazată pe valorile numerice ale probabilității de apariție a unui eveniment potențial dăunător, vulnerabilitatea elementelor expuse și a consecințelor, finalizată printr-o valoare numerică a riscului.
Probabilitatea de producere	Vezi probabilitatea deplasării
Estimarea riscului	Procesul de formulare a unei recomandări de apreciere dacă riscurile existente sunt acceptabile și măsurile actuale de control al riscurilor sunt adecvate și, dacă nu, dacă măsurile alternative de control al riscurilor sunt justificate sau vor fi puse în aplicare.
Controlul riscului	Punerea în aplicare și executarea acțiunilor de control al riscului și reevaluarea periodică a eficienței acestor acțiuni.
Evaluarea riscului	Etapa în care valorile și judecata intră în procesul decizional, în mod explicit sau implicit, prin includerea luării în considerare a importanței riscurilor estimate și a consecințelor sociale, de mediu și economice asociate, pentru a identifica o serie de alternative pentru gestionarea riscurilor.
Managementul riscului	Aplicarea sistematică a politicilor, procedurilor și practicilor la sarcinile de identificare, analiză, evaluare, monitorizare și atenuare a riscurilor.

Reducerea riscului	Aplicarea unor tehnici și principii adecvate pentru a reduce fie probabilitatea unui eveniment, fie consecințele sale negative, sau ambele.
Probabilitatea deplasării	Probabilitatea ca o alunecare de teren specificată să atingă o anumită distanță de deplasare pe versant sau să afecteze o anumită zonă.
Scenariul	O singură realizare a consecințelor unui anumit eveniment (sau unei secvențe de evenimente) având o anumită probabilitate de apariție.
Riscul societal	Riscul cumulativ estimat pentru toate persoanele expuse la un hazard de alunecări de teren în zona de consultare.
Susceptibilitatea	Vezi Susceptibilitatea la alunecări de teren
Probabilitatea spațio-temporală a unui element supus riscului	Probabilitatea ca elementul supus riscului să se afle pe direcția alunecării de teren în momentul producerii acesteia. Este expresia cantitativă a expunerii.
Riscul tolerabil	Un risc dintr-o serie pe care o poate suporta societatea astfel încît să își asigure unele beneficii.
Riscul voluntar	Un risc cu care o persoană se confruntă în mod voluntar pentru a obține un beneficiu.
Vulnerabilitatea	Gradul de pierderi al unui anumit element sau set de elemente expuse la producerea unei alunecări de teren cu o anumită magnitudine / intensitate.
Zonarea	Împărțirea terenurilor în zone sau domenii omogene și clasificarea acestora în funcție de gradele de susceptibilitate, hazard sau risc de alunecări de teren actuale sau potențiale.

Appendix E: Nomenclature: Type of Landslide

Landslide Type

1) Rock Avalanches, Basic Characteristics and Classification Criteria

Rock avalanches initiate as large rock slides and convert into flows during their motion. At the same time rock slope failure of sliding types may not convert into granular flow and detached rock mass can move as a block slide, retaining its integrity completely or partially up to the halt of motion. Presence or absence of motion style transformation can be considered for the rock slide and rock avalanche classification.

Considering drastic difference between motion mechanisms typical of rock avalanches at their initiation (sliding) and during subsequent motion (flow), the addendum to the landslide classification system can be proposed allowing stricter classification of rock slope failures that either experienced transformation from block to flow slides or not. According to the addendum, type name of the landslide that originate on the slope composed of bedrock should consists of three words (except rock falls):

(1) Type of the initial movement (planar, wedge, rotational, irregular, compound);

(2) Rock, indicating it originated in bedrock;

(3) Type of the resultant motion (either slide or flow, and, thus, avalanche).

The above multistage classification of rock slope failures can be complemented with classifications based on three morphological characteristics of their deposits (Fig. 1):

(1) Confinement conditions;
(2) Debris distribution along the rock avalanche path;
(3) Debris motion directivity.

Besides providing information on debris motion mechanism(s), these characteristics predetermine the assessment of exposure of elements at risk that might be affected by rock avalanche.

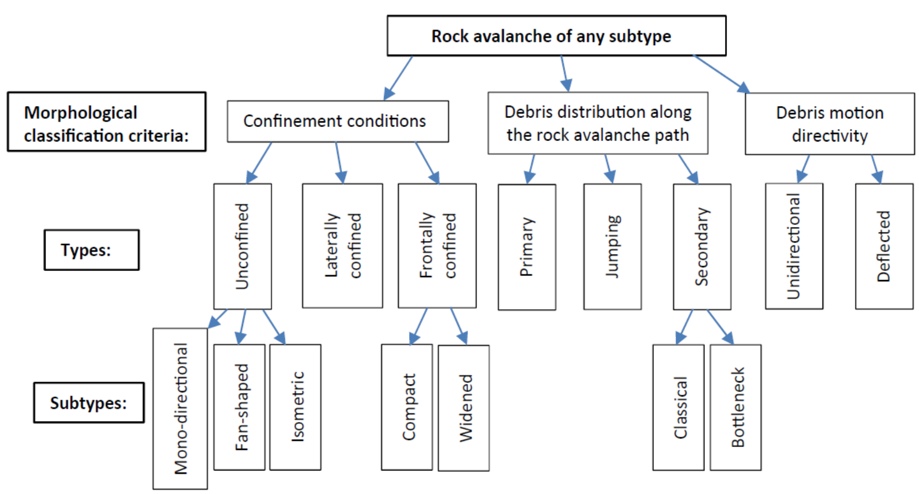


Fig. 1 Multilevel classification of rock avalanches based on morphological characteristics

These types and subtypes are interrelated and use of any of them to describe a particular rock avalanche should be determined by the main goal of its study. Rather often the geomorphic conditions change along the travel path so that rock avalanche type or subtype changes. It can be exemplified by the 1949 Khait rock avalanche (Fig. 2) that could be classified initially as the primary deflected laterally confined irregular rock avalanche, while later, when it entered the Yarhych River valley, as unconfined fan-shaped unidirectional one.

Fig. 2 The 1949 Khait laterally confined irregular rock avalanche with distal fan-shaped blade

Landslide geometrical characterization

1) Landslide length, width and aspect ratio: path-dependent measurement and new nomenclature

Length (L), width (W) and aspect ratio (ε, L/W) are elementary parameters widely adopted to characterize landslide geometry. Aspect ratio (ε) had been associated with the propagation of landslide along its movement path. However, current automatic measurement algorithms have not effectively considered the path of landslide movement, therefore only measure “path-independent” instead of “path-dependent” geometric parameters.

A new approach for measuring path-dependent landslide L, W and ε, in which path-dependent landslide L (L_{pdep}) is measured as the path distance from the landslide crown to its tip along the central line of landslide movement, and path-dependent landslide W (W_{pdep}) is measured as the weighted average lateral extent, across the central line of landslide movement. Specifically, W_{pdep} is calculated indirectly through dividing the landslide area by its length (A/L_{pdep}), and path-dependent landslide ε (ε_{pdep}) can be calculated by L_{pdep}^2/A. The central line of landslide movement, i.e., landslide profile, is a three-dimensional (3D) polyline generated by the freely available software ALPA

(*Automatic Landslide Profile Analysis*), and all these path-dependent geometric parameters can be measured either in 3D space or in two-dimensional (2D) space (in the horizontal plane). Path-dependent parameters can be effectively measured by the proposed profile based approach, and could be significantly different from path-independent parameters especially for long-narrow and tortuous landslides.

An overview shows that significant divergencies exist between current definitions of landslide L, W and ε. In order to moderate the raised ambiguities and confusions, a "physically-indicative" inclusive nomenclature somehow embracing all current representative definitions, is suggested.

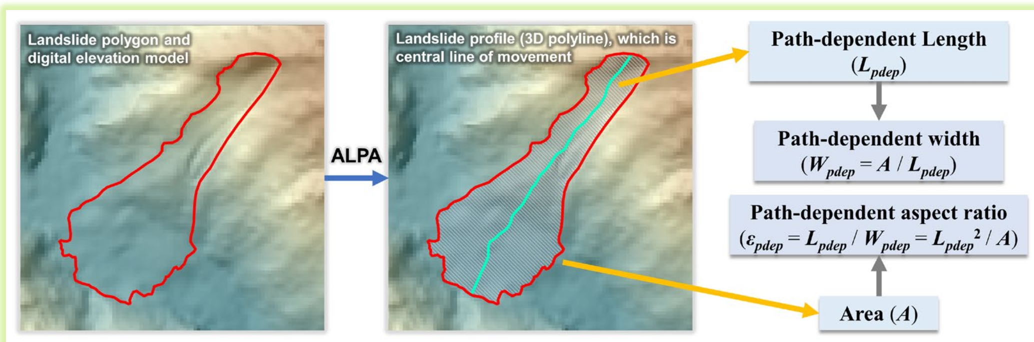


Fig. 3 Conceptual overview of the new approach for measuring path-dependent landslide length, width and aspect ratio (i.e., L_{pdep}, W_{pdep} and ε_{pdep}) based on landslide profile (i.e., central line of movement).

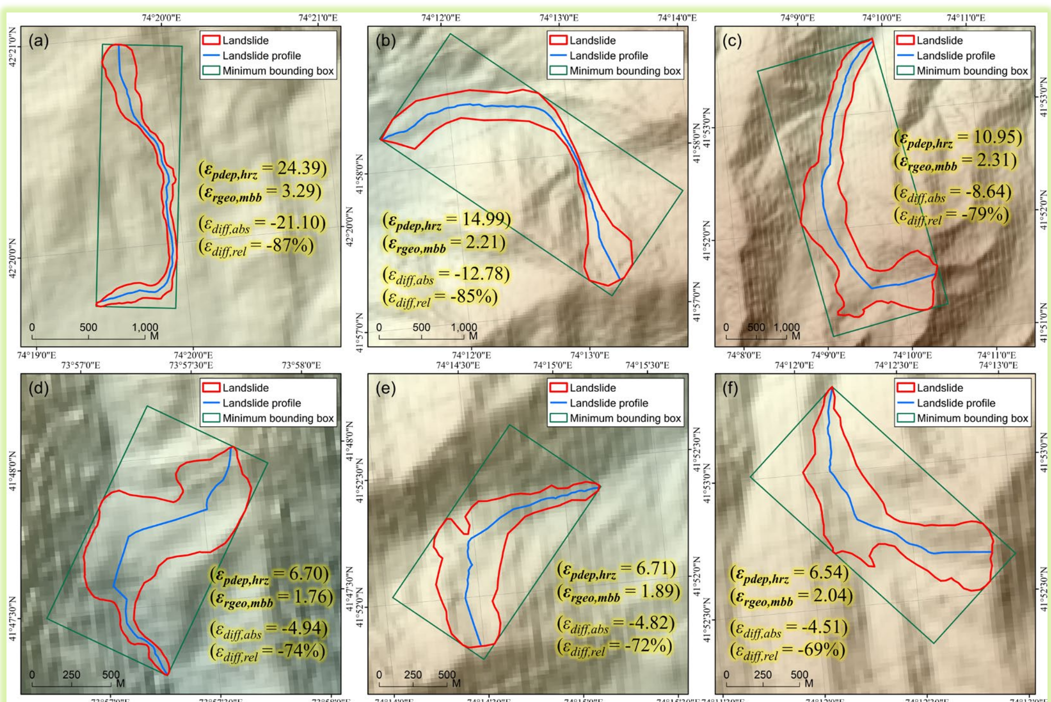


Fig. 4 Aspect ratios of 6 landslide cases with the most significant relative differences of aspect ratio. $\varepsilon_{pdep,hrz}$ is horizontal path-dependent landslide aspect ratio measured with the profiled based approach.

Table 3 A physically indicative inclusive nomenclature that embraces current representative definitions of landslide length, width and aspect ratio

Criterion			Definition			Corresponding current representative definitions
DM	DP	Set	Length (L)	Width (W)	Aspect ratio (L/W, e)	
3D	DEP	Overall path-dependent	Overall path-dependent length ($L_{pdep,all}$): path distance from crown to tip along central line of movement in three-dimensional (3D) space	Overall path-dependent width ($W_{pdep,all}$): weighted average (weighted by length) lateral extent across central line of movement in three-dimensional (3D) space	Overall path-dependent aspect ratio ($e_{pdep,all}$): ratio between overall path-dependent length and overall path-dependent width ($L_{pdep,all}/W_{pdep,all}$)	• Path-dependent definitions in 3D space in this study • "Length of center line (L_{cl})" in Cruden and Varnes (1996)
	IND	Overall path-independent	Overall path-independent length ($L_{pind,all}$): direct distance from crown to tip in three-dimensional (3D) space	Overall path-independent width ($W_{pind,all}$): maximum or other estimates of lateral extent perpendicular to direct length in three-dimensional (3D) space	Overall path-independent aspect ratio ($e_{pind,all}$): ratio between overall path-independent length and overall path-independent width ($L_{pind,all}/W_{pind,all}$)	• "Total length (L)" in Cruden and Varnes (1996) • Somehow definitions for displaced mass and rupture surface of landside in Cruden and Varnes (1996)
2D	DEP	Horizontal path-dependent	Horizontal path-dependent length ($L_{pdep,hrz}$): path distance from crown to tip along central line of movement in two-dimensional (2D) space (in the horizontal plane)	Horizontal path-dependent width ($W_{pdep,hrz}$): weighted average (weighted by length) lateral extent across central line of movement in two-dimensional (2D) space (in the horizontal plane)	Horizontal path-dependent aspect ratio ($e_{pdep,hrz}$): ratio between horizontal path-dependent length and horizontal path-dependent width ($L_{pdep,hrz}/W_{pdep,hrz}$)	• Path-dependent definitions in 2D space in this study • Horizontal path-dependent length ($L_{pdep,hrz}$) is often called "runout" • Somehow length defined in Golovko et al. (2017)
	IND	Horizontal path-independent	Horizontal path-independent length ($L_{pind,hrz}$): direct distance from crown to tip in two-dimensional (2D) space (in the horizontal plane)	Horizontal path-independent width ($W_{pind,hrz}$): maximum or other estimates of lateral extent perpendicular to direct length in two-dimensional (2D) space (in the horizontal plane)	Horizontal path-independent aspect ratio ($e_{pind,hrz}$): ratio between horizontal path-independent length and horizontal path-independent width ($L_{pind,hrz}/W_{pind,hrz}$)	• Definitions in 2D space by simple statement (e.g., Ling and Chigira 2020) • Somehow definitions based on regular geometry abstraction (e.g., NiculiţĂ 2016; Taylor et al. 2018; Pirasteh et al. 2020)

DM dimension of measurement, indicating whether landslide L and W are measured in 3D space or in 2D space (in the horizontal plane), *DP* dependency on path, indicating whether landslide L and W are path-dependent (DEP) or path-independent (IND)

Fig. 5 A physically-indicative inclusive nomenclature that embraces current representative definitions of landslide length, width and aspect ratio.

2) Landslide longitudinal shape: a new concept for complementing landslide aspect ratio

Aspect ratio is an elementary parameter widely adopted to characterize landslide geometry. Nevertheless, it in essence reflects an overall elongation of landslide only, and cannot reflect variation of width along central line of movement.

The new concept "landslide longitudinal shape" for complementing landslide aspect ratio, and the methodology for interpreting it based on generation and analysis of landslide profile, are proposed. Relative width change and relative width fluctuation are defined as parameters quantitatively describing landslide longitudinal shape, and five different types of shape (rectangle, widening, narrowing, spindle and hourglass) are predefined for qualitatively classifying it.

A case study showed that landslide longitudinal shape can provide additional information and therefore is a complement to aspect ratio. Landslides with larger aspect ratios (more elongated) are more possibly characterized by a narrowing overall varying trend and a stronger fluctuation of width. Landslides with similar longitudinal shapes of heardscarp zones were found to have transition-deposition zones with diverse longitudinal shapes, which is caused by diverse topographic confinements and forces governing motion.

Longitudinal shape is not just a geometric parameter, but can somehow help to understand motion constraints of landslides.

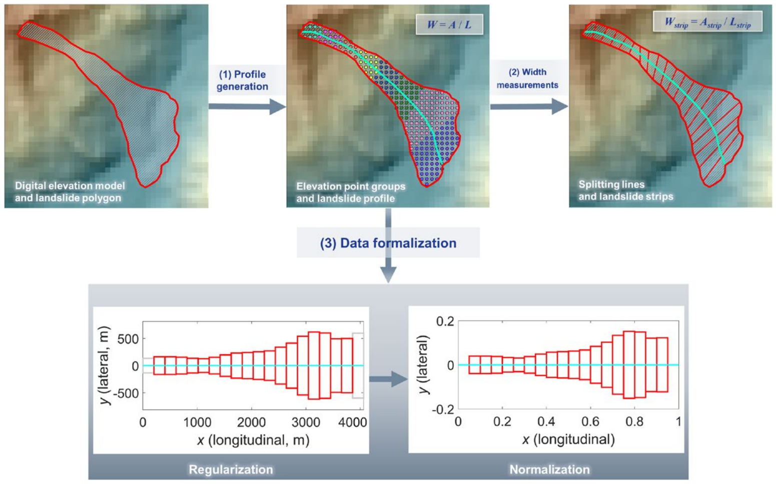


Fig. 6 Major steps to prepare data for interpreting landslide longitudinal shape.

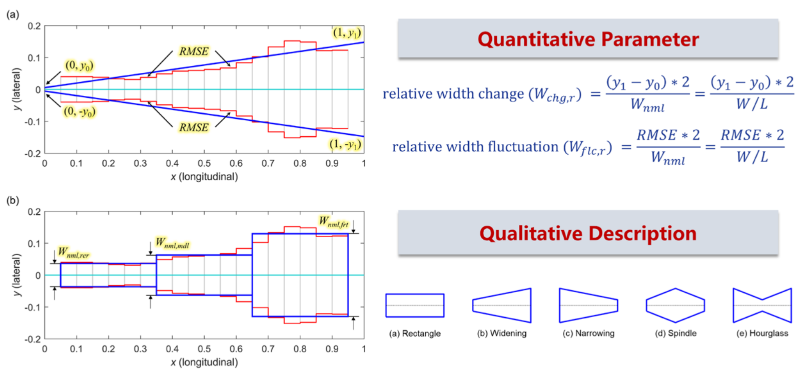


Fig. 7 Quantitative parameters and qualitative descriptions of landslide longitudinal shape.

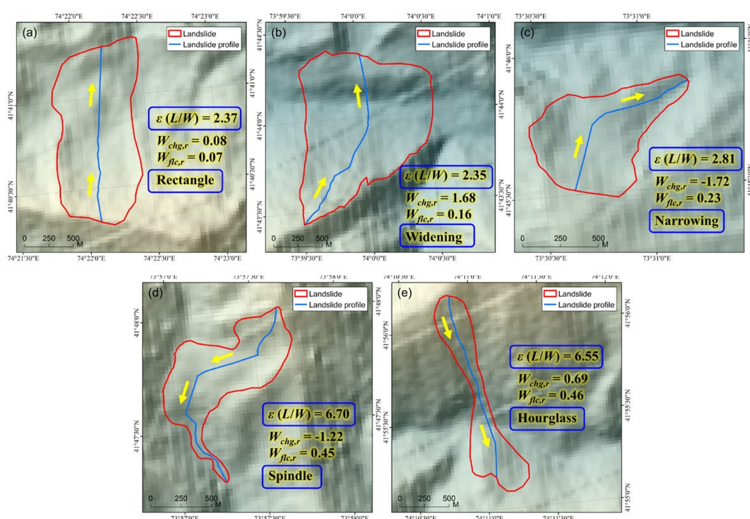


Fig. 8 Profiles, aspect ratios, relative width changes, relative width fluctuations and longitudinal shape types of five typical landslides.

Appendix F: Nomenclature: Landslide Volume

Proposed volume classification

Proposed Landslide Volume classification		
Size class	V, range (m^3)	Potential consequences
0	<10^0	Less than $1m^3$. May be subdivided into smaller volumes for specific rock fall assessments. Likely rockfalls, very rapid, even such small volumes have killed. Very localised events.
1	1 - <10^1	1 - < $10m^3$. Very localised occurrence and damage.
2	10 - <10^2	10 - $100m^3$. Very localized damage, known to have killed workers in small gullies, pedestrians, drivers of vehicles, damage small buildings
3	10^2 – <10^3	100 - $1,000m^3$. Could bury cars, destroy a small buildings, break trees, block culverts, derail trains
4	10^3 – <10^4	1000 - $10,000m^3$. Could destroy larger buildings, damage concrete bridge piers, block or damage highways and pipelines
5	10^4 – <10^5	10,000 - $100,000m^3$. Could destroy parts of villages, destroy sections of infrastructure corridors, bridges, could block creeks
6	10^5 – <10^6	100,000 - $1,000,000m^3$. Could destroy parts of towns, destroy forests of 2 km^2 in area, block creeks and small rivers
7	10^6 – <10^7	1,000,000 - $10,000,000m^3$. Could destroy towns, obliterate valleys or fans up to several tens of km2 in size, dam rivers
8	10^7 – <10^8	10,000,000 - $100,000,000m^3$. Could destroy parts of cities, obliterate valleys or alluvial/debris fans up to several tens of km^2 in size, dam large rivers
9	10^8 – <10^9	100,000,000 - $1,000,000,000m^3$. Could destroy cities, inundate large valleys up to 100 km^2 in size, dam large rivers

10	10^9 and above	> 1,000,000,000m^3. Vast and complete destruction over hundreds of km^2