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# LANDSLIDE TERMINOLOGY

## Canadian Technical Guidelines and Best Practices related to Landslides: a national initiative for loss reduction

**P. Bobrowsky and R. Couture**

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# Canadian Technical Guidelines and Best Practices related to Landslides: a national initiative for loss reduction

# LANDSLIDE TERMINOLOGY

**Note to Reader**

This is the tenth publication in a series of Geological Survey of Canada Open Files that has appeared during the past 3 years. This open file is a revised and updated version of an earlier publication (OF 6824) on the same topic (Couture, 2011). The series forms the basis of the *Canadian Technical Guidelines and Best Practices related to Landslides: a national initiative for loss reduction*. Once all Open Files have been published, they will be compiled, updated and published as a GSC Bulletin. The intent is to have each Open File in the series correspond to a chapter in the Bulletin. Send comments on this or other Open Files in this series to Dr. P Bobrowsky at pbobrows@NRCan.gc.ca

## 1. INTRODUCTION

The purpose of this glossary of landslide terms is to provide a useful compendium of terms used by the landslide community in Canada and elsewhere as well as to encourage a common language of communication by all those involved in landslide studies around the world.

Several publications that include landslide terminology exist. Many but not all are included in this document. Cruden and Varnes (1996) are consistent with the terminology suggested by UNESCO's Working Party on the World Landslide Inventory (WP/WLI, 1993) and provide a historical perspective of landslide terminology. Wise et al. (2004) are consistent with the hazard and risk terminology recommended by the Canadian Standards Association (1997) and is used by most landslide professionals in western Canada. Fell et al. (2008) suggest landslide susceptibility, hazard and risk terminology for use throughout the world. Definitions in this publication are mainly from WP/WLI (1993), Wise et al. (2004) and Fell et al. (2008) unless otherwise indicated. Specific terms and definitions are proposed and used by the various authors in this series. We recommend that readers rely on these most recent definitions in their day to day work. The key contributions and definitions in this series are listed at the end of this Open File as references #62 – #69.

## 2. ABBREVIATIONS

C: Consequence (due to a hazardous landslide)

$P_{(H)}$: Annual probability of a landslide or probability of occurrence of a landslide.

$P_{(HA)}$: Partial risk (annual probability of occurrence of landslide impacting an element at risk at the site when the landslide affects this site)

$P_{(S:H)}$: Probability of spatial impact by the landslide on the property, taking into account the travel distance and travel direction.

$P_{(T:S)}$: Temporal spatial probability. For houses and other buildings $P_{(T:S)}$ is 1.0. For vehicles and other moving elements at risk $1.0 < P_{(T:S)} > 0$.

$R_{(S)}$: Risk (annual probability of loss)

$V_{(L:T)}$: Vulnerability of the individual or the element at risk; probability of loss or damage given the impact.

## 3. GLOSSARY

**Abandoned**:

**a)** Inactive landslide no longer affected by its original causes. **(5)**

**b)** Landslide is inactive and the apparent causes for its movement are no longer present in the environment. For example, a river that formerly destabilized the landslide by eroding its toe has changed course permanently. **(33)**

**c)** Perhaps, however, the river which had been eroding the toe of the moving slope has itself changed course and the landslide is abandoned. **(43)**

**Acceptable Risk**:

**a)** Level of loss a society or community considers acceptable given existing social, economic, political, cultural and technical conditions. **(10)**

**b)** Risk that, for the purposes of life or work, society is prepared to accept as is, with no risk management; society does not typically consider expenditure to further reduce such risk as justifiable. **(13)**

**c)** Level of potential losses that a society or community considers acceptable given existing social, economic, political, cultural, technical and environmental conditions. **(24)**

**d)** Acceptable risk is a risk for which, for the purposes of life or work, stakeholders are prepared to accept "as is", and for which no risk control is needed. **(40)**

**e)** Risk that society or an individual is prepared to accept and for which no further risk reduction is required. **(68)**

**Accumulated Mass**: Accumulation: Volume of displaced material that lies above the original ground surface of a landslide (see Fig. 1). **(19, 38)**

**Active**:

**a)** Landslide was moving at time of observation (field visit) or when reported and entered into database (reported occurrence). **(3)**

**b)** Term indicates that a landslide is currently moving. **(33)**

**c)** Qualifying descriptor (superscript) used to indicate that a material is undergoing deposition at the present time. **(37)**

**d)** Currently moving. **(36)**

**e)** 1. Landslide that is currently moving; first-time movement or reactivated; or
2. Form of mitigation that requires some engineering to prevent, reduce or eliminate the hazard, or to design protection to the elements at risk. **(38)**

**f)** Active landslides are those that are currently moving. **(43)**

**Activity**: Stage of development of a landslide, including the state of activity, distribution of activity, and style of activity. **(13)**

**Advancing**:

**a)** Rupture surface is extending in the same direction as the movement of displaced material. **(33)**

**b)** Activity where the rupture surface extends in the direction of movement. **(38)**

**ALARP:** As Low As Reasonably Practicable; with reference to risk. **(13)**

**Analysis**: Process to determine the nature and level of hazard and risk; typically includes scope definition, identification and estimation. **(13)**

**Annual Exceedance Probability (AEP)**: Estimated probability that an event of specified magnitude will be exceeded in a year. **(13, 34)**

**Assessment**: Overall process of hazard or risk identification, analysis and evaluation. **(25)**

**Cause(s)**: see Preparatory Causes

**Climate Change**:

**a)** Change in the state of the climate that can be identified (e.g., by using statistical tests) by changes in the mean and/or the variability of its properties and that persists for an extended period, typically decades or longer. Climate change may be due to natural internal processes or external forces, or to persistent anthropogenic changes in the composition of the atmosphere or in land use. **(1)**

**b)** Refers to statistically significant variation in either the mean state of the climate or in its variability, persisting for an extended period (typically decades or longer). **(10)**

**c)** Recognizable change in climate as determined from two or more periods with minimum durations of 30 years each. **(22)**

**d)** Inter-governmental Panel on Climate Change (IPCC) defines climate change as: "a change in the state of the climate that can be identified (e.g., by using statistical tests) by changes in the mean and/or the variability of its properties, and that persists for an extended period, typically decades or longer. Climate change may be due to natural internal processes or external forcing or to persistent anthropogenic changes in the composition of the atmosphere or in land use". **(24)**

**e)** United Nations Framework Convention on Climate Change (UNFCCC) defines climate change as "a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods". **(24)**

**Complex**:

**a)** Slide involves one of five main types of movement followed by two or more of the other main types of movement. **(3)**

**b)** Type of landslide movement that is best described by combination of two or more other types of landslide movement. For example a debris slide-debris flow is a complex type of landslide. **(14)**

**c)** Complex landslide exhibits at least two types of movement (falling, toppling, sliding, spreading and flowing) in sequence. **(19)**

**d)** Five types of landslides may sometimes be combined or may succeed each other, forming a sixth type: a composite and complex movement, which consists of more than one type (e.g. a rotational-translational slide) or those where one type of failure develops into a second type (e.g. slump-earthflow). **(29)**

**e)** Landslide that involves more than one type of failure mode at different points within it. For example, a rock fall translates into a debris flow. **(33)**

**f)** Activity where a landslide exhibits at least two types of movement (fall, topple, slide, spread, or flow) in sequence. **(38)**

**g)** Many landslides, including most large ones, are complex, that is, they involve more than one type of movement. **(43)**

**h)** More often than not, slope movements involve a combination of one or more of the principal types of movement described above, either within various parts of moving mass or at different stages in development of the movements. These are termed complex slope movements. **(54)**

**i)** Landslides involve the combination of two or more types of movement. Commonly one type of movement starts the material moving, such as a debris slide, and once underway the material takes on the character of another type of movement, such as a debris flow. **(56)**

**j)** Sixth mode of movement included in Varnes (1978), was dropped from the WP/WLI classification system and, if required, is derived by combining the other five modes of movement. Complex, however, is retained as a descriptor of the style of activity. **(63)**

**Composite**:

**a)** Landslide exhibits at least two types of movement simultaneously in different parts of the displacing mass. **(19)**

**b)** Landslide's movement combines more than one type of movement simultaneously. For example a sliding failure is accompanied by extensive internal deformation of the sliding mass. **(33)**

**c)** Activity where a landslide exhibits at least two types of movement (fall, topple, slide, spread, or flow) in different parts of the displaced mass at the same time. **(38)**

**Confining**:

**a)** Displacement in the head of the landslide is taken up by bulging in its lower parts without a rupture surface at the toe. **(33)**

**b)** Activity where there is a scarp but no rupture surface visible at the foot of the displaced mass. **(38)**

**Consequence**:

**a)** An impact such as economic, social or environmental damage/improvement that may result from a hazard. It may be expressed quantitatively (e.g. monetary value), by category (e.g. high, medium, low) or descriptively. **(8)**

**b)** Outcome or potential outcome arising from a landslide, expressed qualitatively or quantitatively in terms of loss, disadvantage (or gain), damage, injury or loss of life; the effect on human well-being, property, the environment, other things of value, or a combination of these; or **(13)**

**c)** An estimate of the impact of a hazard, the severity of the damage, or the loss to social, economic and/or resource values. **(14)**

**d)** Outcome of an event affecting objectives. **(25)**

**e)** Outcome or impact of an event. There can be more than one consequence from one event, and consequences can range from positive to negative. Consequences can be expressed qualitatively or quantitatively. **(34)**

**f)** Consequence is the effect on human well-being, property, the environment, or other things of value; or a combination of these (adapted from CSA 1997). Conceptually, consequence is the change, loss, or damage to the elements caused by the landslide. **(40)**

**g)** Probability of total loss or damage, or a proportion of loss or damage, to an element at risk; combination of spatial probability, temporal probability and vulnerability; $C = P_{(S:H)} \times P_{(T:S)} \times V_{(L:T)}$. **(40)**

**h)** Result or effect on human well-being, property or the environment due to a landslide occurring. **(51)**

**i)** Consequence (C) is the resulting loss or injury, or the potential loss or injury. It is the product of the elements at risk and the vulnerability (E x V), and can be quantified if the element at risk is expressed as a value and the vulnerability is expressed numerically. **(56)**

**j)** Outcome of a landslide that adversely affects human health and safety, property, aspects of the environment and/or financial interests; can be expressed qualitatively or quantitatively. **(68)**

**Consultation Zone:** Is a zone that includes existing and proposed development in one or more jurisdictional areas, that contains the largest credible area potentially affected by one or more concurrent landslides. **(66)**

**Control**:

**a)** Process of decision making for managing hazard or risk, and implementation or enforcement of hazard or risk mitigation measures and re-evaluation of the effectiveness from time to time, using the results of hazard or risk assessment as one input. **(16)**

**b)** Measure that is modifying risk. Controls include any process, policy, device, practice, or other actions which modify risk. Controls may not always exert the intended or assumed modifying effect. **(25)**

**Creep**:

**a)** Deformation that continues under constant stress.

**b)** Slow, imperceptible movement of soil and rock downslope. **(4)**

**c)** Slow, gradual, more or less continuous movement of ice, soil, and faults under stress. **(12)**

**d)** Slow, more or less continuous type of downslope landslide movement of soil and rock under gravitational stresses. It often occurs on an open slope. **(14)**

**e)** Imperceptibly slow movement of surface soil material downslope under the effect of gravity. **(15)**

**f)** Imperceptibly slow, more or less continuous, downward and outward movement of soil or rock on slopes. The movement is essentially viscous, under shear stresses sufficient to produce permanent deformation but too small to produce shear failure as in a landslide. **(20)**

**g)** (1) Extremely slow downslope flow of sediment on the surface. (2) Slow, more or less continuous movement on a fault. Creeping faults either lack earthquakes or have only small ones. **(22)**

**h)** Any extremely slow slope movements which are imperceptible except through long-period measurements. **(32)**

**i)** Imperceptibly slow, steady downward movement of slope-forming soil or rock indicated by curved tree trunks, bent fences or retaining walls, tilted poles or fences, and small soil ripples or terracettes. **(34, 35)**

**j)** Imperceptibility slow, more or less continuous movement of soil or rock on slopes. The movement is essentially flow of a highly viscous medium under shear stresses sufficient to produce deformation but too small to produce shear failure as in a landslide. **(35)**

**k)** Very slow to extremely slow rate of movement; not a recommended term, use very slow or extremely slow instead. **(38)**

**l)** Soil creep is a very slow downslope movement of the near-surface part of soil profile, at a rate usually decreasing exponentially with depth. **(43)**

**m)** Slow, long-term permanent deformation of sediment under constant load. **(45)**

**n)** Important process in cohesive soils on slopes. There is still much debate about its cause, but water, temperature, stress, and biotic variations are usually regarded as important, with evidence that rearrangement of soil particles, following solution of some materials could be a major factor. **(55)**

**o)** Shallow, slow-moving form of an earth flow involving thin layers of near-surface soil. **(56)**

**p)** Slow, steady downslope movement of soil or rock, often indicated by curved tree trunks, bent fences or retaining walls, tilted poles or fences. **(57)**

**Criteria**: Terms of reference against which the significance of a hazard or risk are evaluated. **(25)**

**Crown**:

**a)** Slope from which the landslide is starting. **(3)**

**b)** Steep, bare or sparsely vegetated main scarp, usually 'horseshoe' shaped and often displaying vertical striations. Cracks and minor scarps are frequently found in the vicinity. **(19)**

**c)** Material that is still in place, practically undisplaced and adjacent to the highest parts of the main scarp. **(34)**

**d)** Non-displaced ground adjacent to the highest portion of the main scarp of a landslide (see Fig. 1). **(38)**

**Danger (Threat)**: Natural phenomenon that could lead to loss, disadvantage, damage, injury or loss of life; does not include any forecasting; also see Hazard. **(13)**

**Debris**:

**a)** Any accumulation of rock fragments; detritus. **(13)**

**b)** Soil that contains a significant proportion of coarse material; 20% to 80% inorganic particles >2 mm (the upper limit of sand-size particles), and the remainder <2 mm. **(13)**

**c)** An accumulation of loose, predominantly coarse grained soil and rocks fragments, and sometimes with large organic material such as limbs and trunks of trees, that have become mixed together in an unsorted fashion. Sometimes the term is used to refer solely to organic material, as in "logging debris". **(14)**

**d)** Slope forming material that contains a significant proportion of coarse material; 20 per cent to 80 per cent of the particles are larger than 2mm; the remainder less than 2mm in size. **(32)**

**e)** Coarse engineering soil, with 20-80 percent of the particles larger than 2mm. **(34)**

**f)** Refers to an engineering soil, generally surficial, that contains a significant proportion of coarse material. **(54)**

**g)** Composed of predominantly coarse grained soil (boulder through to gravel and sand sized materials), or as mentioned above, can also include highly fractured bedrock. The strength of coarse grained soil is generally derived from friction between the grains. Woody debris such as trees or logs, or other organic material, is sometimes incorporated with the inorganic debris. **(56)**

**Debris Avalanche**:

**a)** Flow of debris of different particle sizes that takes on catastrophic proportions. Volumes of 50-100 million cubic meters travelling at velocities of 300-400km/hr have been measured. **(15)**

**b)** Fast-moving avalanche of loose debris that flows out a considerable distance from its source. **(22)**

**c)** Extremely rapid downward movement of rocks, soil, mud and other debris mixed with air and water. **(32)**

**d)** Very rapid to extremely rapid landslide on a steep slope which is unconfined to a channel. Debris avalanches often initiate debris flows. **(34)**

**e)** Variety of very rapid to extremely rapid debris flow. **(35)**

**f)** Rapid downslope movement on steep slopes of saturated soil and/or surficial material, commonly including vegetative debris; a very rapid to extremely rapid debris flow. **(37)**

**g)** Type of landslide characterized by the very rapid movement of debris downhill. **(38)**

**h)** Debris slides or avalanches occur in surficial deposits of granular material. The rupture surface is roughly parallel to the inclination of the bedrock surface. **(42)**

**i)** Large volume, extremely rapid, and, therefore, highly destructive mass movement involving unconsolidated material. **(43)**

**j)** Debris or rock avalanches are sourced in a similar manner to debris or rock falls, but involve large volumes of failed material, in which the interacting clasts collide and share their momentum in a manner similar to that prevailing in a grain flow. **(45)**

**k)** Generally long and narrow and often leave a serrate or V-shaped scar tapering uphill at the head in contrast to the horseshoe-shaped scarp of a slump. **(54)**

**l)** Variety of very rapid to extremely rapid debris flow. **(57)**

**Debris Flow**:

**a)** Form of rapid mass movement in which loose soil, rock and sometimes organic matter combine with water to form a slurry that flows downslope. They have been informally and inappropriately called “mudslides” due to large quantity of fine material that may be present in the flow. Occasionally, as a rotational or translational slide gains velocity and the internal mass loses cohesion or gains water, it may evolve into a debris flow. Dry flows can sometimes occur in cohesionless sand (sand flows). Debris flows can be deadly as they can be extremely rapid and may occur without warning. **(3)**

**b)** Loose sediment plus water that is pulled downslope directly by gravity. **(12)**

**c)** Type of landslide characterized by water-charged, predominantly coarse grained soil and rock fragments, and sometimes large organic material, flowing rapidly down a pre-existing channel. Sometimes referred to as channelized debris flow, debris torrent, or mudflow. **(14)**

**d)** Any flow of sediment moving at any velocity downslope in which a range of particle sizes is involved. **(15)**

**e)** Consists of a mixture of the fine material (sand, silt and clay), coarse material (gravel and boulders), with a variable quantity of water, that forms a muddy slurry which moves downslope, usually in surges induced by gravity and the sudden collapse of bank material. **(19)**

**f)** Rapid flow of saturated debris. **(20)**

**g)** Slurry of rocks, sand, and water flowing down a valley. Water generally makes up less than half the flow's volume. **(22)**

**h)** Very rapid to extremely rapid flow (>1 m.s-1) of saturated non-plastic debris in a steep channel. Characteristic of a debris flow is the presence of an established channel or regular confined path, unlike debris avalanches which are thin, partly or totally saturated and which occur on hillslopes. **(29)**

**i)** Mixture of water and clay, silt, sand and rock fragments that flows rapidly down steep slopes. A debris flow is slower than a mudflow**. (32)**

**j)** Form of rapid mass movement in which soils, rocks, and organic matter combine with entrained air and water to form a slurry that then flows downslope. Debris-flow areas are usually associated with the steep gullies. Individual debris-flow areas can usually be identified by the presence of debris fans at the termini of the drainage basins. **(34, 35)**

**k)** Similar to debris slides, except that debris flows may contain more water and move in a more fluid manner than debris slides. Debris flows generally do not travel beyond the hillslope on which they originate. **(36)**

**l)** Rapid flow of a slurry of saturated debris, including some or all of soil, surficial material, weathered rock mud, boulders, and vegetative debris. A general designation for all types of rapid downslope flow, including mudflows, rapid earthflows, and debris torrents. **(37)**

**m)** Type of landslide characterized by fast moving, unconsolidated, typically saturated debris; open-slope debris flows occur unconfined on a hill slope; confined debris flows occur in a pre-existing channel. **(38)**

**n)** Occur after sliding is initiated by the saturation of debris with water. **(42)**

**o)** Extremely rapid, flow-like mass movement traveling in a steep, established channel and involving a saturated, unsorted mixture of granular soils, organics, and other debris. **(43)**

**p)** Are (pseudo-) plastic, poorly sorted flows, in which clasts float in a fine-grained matrix (mud to sand) with finite shear strength. **(45)**

**q)** Natural debris flow is essentially a normal geological process by which young, steep valleys are widened and deepened. It is likely to recur at periodic intervals. **(46)**

**r)** Called mud flows in some other classifications, are here distinguished from the latter on the basis of particle size. That is, the term debris denotes material that contains relatively high percentages of coarse fragment. **(54)**

**s)** Develop where there is an abundant source of material which can be mobilized by the addition of water. **(55)**

**t)** Can occur on open slopes or in pre-existing channels. Open slope debris flows are also referred to as "debris avalanches". **(56)**

**u)** Rapid mass movement in which loose soils, rocks, and organic matter combine with entrained air and water to form a slurry that then flows downslope, usually associated with steep gullies. **(57)**

**Debris Torrent**:

**a)** Former term for debris flow; not a recommended term.

**b)** Rapid flow of a mixture of water, earth and vegetation debris down a steep, well-defined stream channel. **(20)**

**c)** May begin as debris slides or debris flows but become channelized in streams and moves rapidly downstream. Debris torrents are characterized by long stretches of bare soil and generally unstable channel banks that have been scoured by the rapid movement of debris. As a debris torrent moves through first and second order channels, the volume of material may increase to a much greater size than the initial failure. **(36)**

**d)** Variety of debris flow that includes little fines (silt and clay) and that follows a pre-existing stream channel. **(37)**

**Depleted Mass; Depletion**: Volume of displaced material that overlies the rupture surface but underlies the original ground surface of a landslide (see Fig. 1). **(19, 38)**

**Depth of Displaced Mass ($D_d$)**: Maximum depth of the displaced mass, measured perpendicular to the plane containing the width and length of the displaced mass ($W_d$ and $L_d$) (see Fig. 2). **(19, 38)**

**Depth of Rupture Surface ($D_r$)**: Maximum depth of the rupture surface below the original ground surface, measured perpendicular to the plane containing the width and length of the displaced mass ($W_r$ and $L_r$) (see Fig. 2). **(19, 38)**

**Diminishing**:

**a)** Volume of material being displaced is decreasing with time. **(33)**

**b)** Activity where the volume of displaced material is decreasing. **(38)**

**Disaster**:

**a)** Severe alterations in the normal functioning of a community or a society due to hazardous physical events interacting with vulnerable social conditions, leading to widespread adverse human, material, economic, or environmental effects that require immediate emergency response to satisfy critical human needs and that may require external support for recovery. **(1)**

**b)** Serious disruption of the functioning of a community or a society causing widespread human, material, economic or environmental losses which exceed the ability of the affected community or society to cope with, using its own resources. A disaster is a function of the risk process. It results from the combination of hazards, conditions of vulnerability and insufficient capacity or measures to reduce the potential negative consequences of risk. **(8)**

**c)** Situation or event, which overwhelms local capacity, necessitating a request to national or international level for external assistance (definition considered in EM-DAT); an unforeseen and often sudden event that causes great damage, destruction and human suffering. Though often caused by nature, disasters can have human origins. Wars and civil disturbances that destroy homelands and displace people are included among the causes of disasters. Other causes can be: building collapse, blizzard, drought, epidemic, earthquake, explosion, fire, flood, hazardous material or transportation incident (such as a chemical spill), hurricane, nuclear incident, tornado, or volcano. **(8)**

**d)** Situation or event, which overwhelms local capacity, necessitating a request to national or international level for external assistance. An unforeseen and often sudden event that causes great damage, destruction and human suffering. Though often caused by nature, disasters can have human origins. **(9)**

**e)** Serious disruption of the functioning of a community or a society causing widespread human, material, economic or environmental losses which exceed the ability of the affected community/society to cope using its own resources. **(10)**

**f)** An event involving a significant number of people and/or significant economic damage. **(22)**

**g)** Serious disruption of the functioning of a community or a society involving widespread human, material, economic or environmental losses and impacts, which exceeds the ability of the affected community or society to cope using its own resources. **(24)**

**h)** Calamitous event that causes enormous destruction of life and/or property. **(27)**

**i)** Catastrophe, mishap, calamity or grave occurrence in any area, arising from natural or man-made causes, of by accident or negligence which results in substantial loss of life or human suffering or damage to, and destruction of property, or damage tom and degradation of environment and is of such a nature or magnitude as to be beyond the coping capacity of the community of the affected area. **(32)**

**j)** Catastrophe, mishap, calamity or grave occurrence in any area, arising from natural or man-made causes, or by accident or negligence which results in substantial loss of life or human suffering or damage to, and destruction of, property, or damage to, and degradation of, environment, and is of such a nature or magnitude as to be beyond the coping capacity of the community of the affected area. **(39)**

**k)** Event that severely affects a society, community or project's functioning and inflicts considerable or generalized human, material, economic or environmental destruction that exceeds the capability of a society, community or project city to respond using its own resources. **(41)**

**l)** Concentrated, diverse damages and a collapse of the social fabric or its safety measures define disasters. **(52)**

**m)** Serious disruption of the functioning of a community or a society causing widespread human, material, economic or environmental losses that exceed the ability of the affected community or society to cope using its own resources. **(59)**

**Displaced Material**:

**a)** Material displaced from its original position on the slope by movement in the landslide. It forms both the depleted mass and the accumulation. **(19)**

**b)** Material that has moved away from its original position on the slope. It may be in a deformed or undeformed state. **(34)**

**c)** Material moved from its original position by a landslide; includes both the depleted and accumulated masses (depletion and accumulation) (see Fig. 1). **(38)**

**Distribution of Activity**: Terms that describe where a landslide is moving (advancing, retrogressing, widening, enlarging, confining, diminishing, or moving). **(38, 63)**

**Dormant**:

**a)** Inactive landslide which can be reactivated by its original causes or by other causes. **(3)**

**b)** Landslide is inactive but the apparent causes for its movement are still present in the environment. **(33)**

**c)** Slide that is not presently active but potential for activity still exists. **(36)**

**d)** Inactive landslide that can be reactivated by its original or other causes. **(38)**

**e)** If the causes of movement apparently remain, then the landslides are dormant. **(43)**

**Downslope**: Area of a location that is experiencing ground movement, marked heavily by bulging at the base of the slope. The downslope is also known as the "toe" of the landmass. **(38)**

**Dry**: Material that has no visible moisture. **(38)**

**Early Warning**:

**a)** Provision of timely and effective information, through identified institutions, that allows individuals exposed to a hazard to take action to avoid or reduce their risk and prepare for effective response. **(10)**

**b)** Set of capacities needed to generate and disseminate timely and meaningful warning information to enable individuals, communities and organizations threatened by a hazard to prepare and to act appropriately and in sufficient time to reduce the possibility of harm or loss. **(24)**

**c)** Provision of timely and effective information through identified institutions, which allows individuals exposed to a hazard to take action to avoid or reduce their risk and prepare for effective response. Early-warning systems depend on: understanding and mapping the hazard; monitoring and forecasting; processing and disseminating understandable warnings to political authorities and the population; and undertaking the right, timely actions in response to the warnings. **(28)**

**Early Warning System:** Set of capacities needed to generate and disseminate timely and meaningful warning information to enable individuals, communities, and organizations threatened by a hazard to prepare and act appropriately and in sufficient time to reduce the possibility of harm/loss. **(1)**

**Earth**:

**a)** Soil that contains >80% inorganic particles <2 mm (the upper limit of sand-size particles). **(13)**

**b)** Generic unconsolidated material overlying bedrock. Sometimes used synonymously with soil. With respect to landslides, earth refers to predominately fine grained soils (silt and clay). **(14)**

**c)** Any or a mixture of soil, surficial materials, and weathered rock. **(37)**

**d)** Earth connotes material in which about 80 percent or more of the fragments are smaller than 2mm; it includes a range of materials from non-plastic sand to highly plastic clay. **(54)**

**e)** Earth refers to predominantly fine grained soil (primarily of silt and clay sized materials). The strength of fine grained soil is generally derived from cohesion, the chemical and electrical bonding between the small particles. **(56)**

**Earth Flow**:

**a)** Earthflows can occur on gentle to moderate slopes, generally in fine-grained soil, commonly clay or silt, but also in very weathered, clay-bearing bedrock. The mass in an earthflow moves as a plastic or viscous flow with strong internal deformation. Susceptible marine clay (quick clay) when disturbed is very vulnerable and may lose all shear strength with a change in its natural moisture content and suddenly liquefy, potentially destroying large areas and flowing for several kilometers. Size commonly increases through headscarp retrogression. Slides or lateral spreads may also evolve downslope into earthflows. Earthflows can range from very slow (creep) to rapid and catastrophic. **(3)**

**b)** Mass of soil that moves downslope and undergoes internal deformation. During an earth flow, the landslide mass breaks apart. **(4)**

**c)** Type of landslide, generally relatively large, characterized by the downslope flow of predominately fine grained soils. The viscous-like movement is relatively slow. **(14)**

**d)** Slow viscous flow of material containing a high proportion of silt and clay. **(20)**

**e)** Bowl or depression forming at a head where unstable material collects and flows out. The central area is narrow and usually becomes wider as it reaches the valley floor. Flows generally occur in fine-grained materials or clay-bearing rocks on moderate slopes and with saturated conditions. Dry flows of granular material are also possible. Earthflows have a characteristic “hourglass” shape. **(34, 35)**

**f)** Slowly (imperceptibly) moving mass of earth, commonly containing a high proportion of silt and clay. **(37)**

**g)** Type of landslide characterized by slow to rapid movement of saturated earth in a liquefied state. **(38)**

**h)** Earth flows are large, slow or rapid moving landslides of predominantly fine grained soil and/or weathered volcanic bedrock. They usually involve relatively large tracts of land. **(56)**

**Earth Slide**: Type of landslide, characterized by earth that has moved as a relatively coherent mass along a relatively shallow failure plane. **(38)**

**Elements at Risk**:

**a)** Population, buildings and engineering works, economic activities, public utilities, other infrastructure, and environmental values in an area affected, or potentially affected, by a landslide. **(13)**

**b)** Population, properties, economic activities, including public services etc. at risk in a given area. **(39, 32)**

**c)** When elements are known to be at risk, they are referred to as elements at risk (or again simply elements). **(40)**

**d)** Comprises the population, properties, economic activities, public services, and so on, which are under the threat of disaster in a given area. **(42)**

**e)** Are the population, buildings and engineering works, economic activities, public services utilities, infrastructure and environmental features in the area potentially affected by the landslide hazard. These need to be assessed for existing and proposed development. **(50)**

**f)** Things of social, environmental and economic value, including human well-being and property that may be affected by a landslide. **(51)**

**g)** Means the population, properties, economic activities, including public services, etc., at risk in a given area. **(54, 60)**

**h)** Include any land, resources, environmental values, buildings, economic activities and/or people in the area that may be affected by landslide hazard. **(56)**

**i)** Objects or assets such as human health and safety, property, aspects of the environment and/or financial interests that could be adversely affected by a landslide. **(68)**

**Engineering Slopes**: Processes in which a slope with the potential risk for erosion undergoes structural readjustments or transformations to ensure the slope remains stable. Engineering a potentially dangerous slope may include re-profiling the top of an unstable slope, rock-fall netting, rock bolting, or the addition of retaining walls. **(31)**

**Enlarging**:

**a)** Rupture surface is extending in two or more directions. **(33)**

**b)** Activity where the rupture surface of a landslide is extending in two or more directions. **(38)**

**Erosion**:

**a)** Caused by bank erosion. **(3)**

**b)** Processes of weathering and transport of soil and rock from their natural environment or source. Agents of erosion include wind, water, ice, gravity and living organisms (bioerosion). **(6)**

**c)** Wearing away of the land surface by water, wind, ice, gravity or other natural or anthropogenic agents that abrade, detach and remove soil particles or rock material from one point on the earth's surface, for deposition elsewhere, including gravitational creep and so-called tillage erosion. **(7)**

**d)** Processes that loosen, dissolve, and wear away earth materials. Active agents include gravity, streams, glaciers, winds, and ocean waves. **(12)**

**e)** Process or group of processes whereby surface soil and rock is loosened, dissolved or worn away, and moved from one place to another, by natural processes. Erosion usually involves relatively small amounts of material at a time, but over a long time can involve very large volumes of material. **(14)**

**f)** Localised removal of rock or soil as a result of the action of water, ice, wind, coastal processes or mass movement. **(34)**

**g)** Loosening and removal of materials by wind, moving water, and glacier ice. **(37)**

**h)** Movement of rock or sediment impelled by the energy of relief, gravity and climatic factors such as precipitation or wind flow. **(42)**

**i)** Geomorphic process that detaches and removes material (soil, rock debris, and associated organic matter) from its primary location by some natural erosive agents or through human or animal activity. **(43)**

**j)** Inclusive term for the detachment and removal of soil and rock by the action of running water, wind, waves, flowing ice, and mass movement. **(55)**

**Estimation**: Determination of hazard or risk. **(16)**

**Evaluation**:

**a)** Using values and judgments in the decision process, either explicitly or implicitly, to determine the importance of the estimated hazards or risks, and thereby identify alternatives to manage the hazards or risks. **(13)**

**b)** Process of comparing the results of risk analysis with risk criteria to determine whether the risk and/or its magnitude are acceptable or tolerable. **(25)**

**Event**: Occurrence or change of a particular set of circumstances; a landslide is an example of an event. **(25)**

**Failure**: Condition in which a structure ceases to fulfill the purpose for which it was designed. (**3**)

**Fall**:

**a)** Generally characterised by a rapid to extremely rapid rate of movement with the descent of material characterised by a freefall period. Falls are commonly triggered by earthquakes or erosion processes. **(2)**

**b)** Detachment of soil or rock from a steep slope with little or no shearing. Descent mainly through air by falling, bouncing or rolling. Rapid to extremely rapid. Initial detachment may be by sliding or toppling. **(3)**

**c)** Mass moving nearly vertical and downward under the influence of gravity. **(12)**

**d)** Very rapid downward movement of a mass soil or rock that travels through the air by free fall, leaping, bounding or rolling, with little or no interaction between one moving unit and another. **(14)**

**e)** Usually denotes the free-fall movement of the material from a steep slope or cliff, whereas a topple which is very similar to a fall in many respects, normally involves a pivoting action rather than a complete separation at the base of the failure. **(19)**

**f)** Slope failure that involves vertically downward motion under gravity of a block without internal deformation or rotation. **(22)**

**g)** Slope of movement for which the mass in motion travels most of the distance through the air, and includes free fall movement by leaps and bounds and rolling of fragments of material. A fall starts with the detachment of material from a steep slope along a surface in which little or no shear displacement takes place. **(29)**

**h)** More or less free and extremely rapid descent of masses of soil or rock, of any size from steep slopes or cliffs is called a fall. **(32)**

**i)** Mass that detaches from a steep slope or cliff and descends by free-fall, bouncing, or rolling. **(34)**

**j)** Abrupt movements of material that become detached from steep slopes or cliffs, moving by free-fall, bounding, and rolling. Includes topples, slides, rotational landslides, and translational slides. **(35)**

**k)** Detached movement of soil or rock from a steep slope along a surface on which little or no shear displacement occurs; material then typically descends by falling, bouncing or rolling. **(38)**

**l)** Involve rolling and bouncing of rock and, less commonly, sediment from cliffs or down steep slopes. Initial failure occurs along steeply inclined fractures or other discontinuities in rock or sediment. **(43)**

**m)** Can occur in rock, but also in frozen soils. They are the results of a downward movement of detached blocks falling under the influence of gravity. They commonly occur along river banks where erosion and thawing are most active, leading to bank undercutting and break-off of frozen blocks, sometimes along ice wedges. **(48)**

**n)** Mass of any size is detached from a steep slope or cliff, along a surface on which little or no shear displacement takes place, and descends mostly through the air by free fall, leaping, bounding, or rolling. **(54)**

**o)** In soil or soft rock usually involve only small quantities of material because steep slopes in weak materials are necessarily very short. These falls are usually the result of undercutting of the toe or face of a slope by a river or by wave action. They are facilitated also by weathering and the opening of fissures near a cliff top as a result of freeze-thaw, wetting and drying, earthquake shocks, or tension. **(55)**

**p)** Take place rapidly by free-fall, bouncing, or rolling, and may develop into either slides or flows. **(56)**

**q)** Abrupt movement of materials that become detached from steep slopes or cliffs, moving by free-fall, bouncing, and rolling. **(57)**

**r)** Starts with the detachment of soil or rock from a steep slope along a surface on which little or no shear displacement takes place. The material then descends largely by falling, bouncing or rolling. **(58)**

**s)** Detachment of soil or rock from a steep slope along a surface on which little shear displacement occurs. The material then descends by falling, bouncing or rolling. The movement, which is governed by gravity, is very rapid to extremely rapid….Falling is

typically preceded by small sliding or toppling movements that separate the displaced material from the undisturbed mass. **(63)**

**Flank**:

**a)** Undisplaced material adjacent to the sides of the rupture surface. Compass directions are preferable in describing the flanks but if left and rights are used, they refer to the flanks as viewed from the crown. **(19)**

**b)** Side of the landslides. **(34)**

**c)** Non-displaced material adjacent to the sides of the rupture surface of a landslide; compass directions are preferable in describing the flanks, but 'left' and 'right' can be used looking downslope (see Fig. 1); also see Side scarp. **(38, 48)**

**Flow**:

**a)** Most destructive and turbulent form of landslide. Flows have a high water content which causes the slope material to lose cohesion, turning it into a slurry. They are channelled by the landscape and move rapidly. **(2)**

**b)** Slow to very rapid movement of saturated inter-grain movement predominating over shear surface movements. Initial displacement usually by sliding, rapidly transforming to flow**. (3)**

**c)** Mass movement where the moving body of material behaves like a liquid. **(12)**

**d)** Type of landslide movement that exhibits a plastic or semi-fluid motion similar to a viscous fluid. In most cases flow is accompanied by an abundant amount of water mixed with the material. **(14)**

**e)** Landslide in which the individual particles travel separately within a moving mass. They involve whatever material is available to them and may therefore be highly fractured rock, clastic debris in a fine matrix or a simple, usually fine, grain size. **(19)**

**f)** In mass movement studies, a downslope movement of material along a surface involving internal deformation. **(22)**

**g)** Downward movement of a loose mixture of debris, water and air that moves in a fluid like manner. **(32)**

**h)** Mass that moves down slope with a fluid motion. A significant amount of water may or may not be part of the mass. **(34)**

**i)** Spatially continuous movement of soil or rock, in which surfaces of shear are short-lived, closely spaced and typically not preserved; distribution of velocities in the displaced mass resembles a viscous fluid. **(38)**

**j)** Large and varied group of landslides that share one similarity- the failed material moves in the manner of a fluid. **(43)**

**k)** Flows were first subdivided into skin, bimodal, and multiple retrogressive. Non-standardized terms were then introduced to describe subdivisions of these slope movements: skin flows, bimodal flows, multiple retrogression flows and solifluction. **(48)**

**l)** Many examples of slope movement cannot be classed as falls, topples, slides, or spreads. In unconsolidated materials, these generally take the form of fairly obvious flows, either fast or slow, wet or dry. **(54)**

**m)** Describe movement that resembles a viscous fluid. Some flows occur slowly, others occur rapidly. Velocity within the flowing mass usually decreases with depth and laterally. In most cases, water is an integral component. **(56)**

**n)** General term including many types of mass movement, such as creep, debris flow, debris avalanche, lahar, and mudflows. **(57)**

**o)** Spatially continuous movement in which shear surfaces are short lived, closely spaced and usually not preserved after the event. The distribution of velocities in the displacing mass resembles that in a viscous fluid. **(58)**

**p)** Continuous movement in which surfaces of shear are short-lived, closely spaced and typically not preserved. The distribution of velocities in the displaced material resembles a viscous liquid. The lower boundary of the displaced material can be a surface along which appreciable differential movement has taken place or a thick zone of distributed shear. There is a range of movement from slides to flows that depends on the water conditions, mobility and evolution of the movement. **(63)**

**Foot**:

**a)** Portion of the landslide that has moved beyond the toe of the surface of rupture and overlies the original ground surface. **(3)**

**b)** Portion of a landslide that has moved beyond the toe of the surface of rupture and overlies the original ground surface (see Fig. 1). **(19, 38)**

**c)** Portion of the displaced material that lies down slope from the toe of the surface of rupture. **(34)**

**Frequency**:

**a)** Number of cycles of seismic waves that pass in a second; equals 1/period. **(12)**

**b)** Probability or likelihood of occurrence of a repeating event, such as a landslide, expressed as the number of occurrences per unit time; also a measure of past occurrences per unit time; also see Probability and Likelihood. **(13)**

**c)** Number of events in a given time, such as the number of back-and-forth motions of an earthquake per second. **(22)**

**d)** Number of times an event occurs over a particular period or in a given sample. **(34)**

**e)** Frequency can be defined variously as the number of events of a given size in a given unit of time; the number of events, and their sizes, in each of a succession of time units; and how often a given magnitude of event occurs. **(42)**

**Frozen**: Thermal condition defining soils, sediments, or rock at or below 0°C. Newly proposed descriptor for materials (water content) within the Working Classification of Landslides to encompass landslides in permafrost terrain. **(38)**

**Ground Conditions:** Are the setting on which a process (or processes) act to prepare or trigger a landslide. They include the surface and subsurface characteristics and fabric of the rock or soil, and therefore require both surface and subsurface investigations of a slope to be determined. **(63)**

**Hazard**:

**a)** Potential occurrence of a natural or human-induced physical event that may cause loss of life, injury, or other health impacts, as well as damage and loss to property, infrastructure, livelihoods, service provision, and environmental resources. **(1)**

**b)** Potentially damaging physical event, phenomenon or human activity, which may cause the loss of life or injury, property damage, social and economic disruption or environmental degradation. Hazards can be single, sequential or combined in their origin and effects. Each hazard is characterised by its timing, location, intensity and probability. **(5)**

**c)** Circumstance of an objective threat posed by a future damaging event that will occur under certain conditions. **(8)**

**d)** Physical event, phenomenon or human activity with a certain probability and the potential to result in harm. **(8)**

**e)** Threatening event, or probability of occurrence of a potentially damaging phenomenon within a given time period and area. **(9)**

**f)** Potentially damaging physical event, phenomenon and/or human activity, which may cause the loss of life or injury, property damage, social and economic disruption or environmental

degradation. **(10)**

**g)** Condition with the potential for causing an undesirable consequence; source of potential harm; also see Danger. **(13)**

**h)** Probability that a particular danger (threat) occurs within a given period of time. **(13)**

**i)** Something that presents a potential risk to property and/or life, such as a geological hazard or landslide hazard. **(14)**

**j)** Source of potential harm, or a situation with a potential for causing harm, in terms of human injury; damage to health, property, the environment, and other things of value; or some combination of these. **(16)**

**k)** Used to describe the whole field, a 'hazards' view emphasises phenomena, usually 'physical agents', in the natural or artificial environment that pose threats. **(19)**

**l)** Phenomenon that causes problems for people. **(22)**

**m)** Dangerous phenomenon, substance, human activity or condition that may cause loss of life, injury or other health impacts, property damage, loss of livelihoods and services, social and economic disruption, or environmental damage. **(24)**

**n)** Likelihood of a potentially damaging ground movement event occurring within the area concerned, i.e. ground movement constitutes a hazard. **(31)**

**o)** Threatening event or the probability of occurrence of a potentially damaging phenomenon (e.g., an earthquake of a large flood) within a given time period and area. **(32)**

**p)** Threatening event or the probability of occurrence of a potentially damaging phenomenon (e.g., an earthquake, a cyclonic storm or a large flood) within a given time period and area. **(39)**

**q)** Degree to which a place or human settlement is threatened by natural phenomena or other types of events over a specific period of time. Hazards can be classified by their origin: natural, technological and social. The complexity and interrelation of the phenomena that may pose such threats lead to nuances in deciding the manner hazards should be designated and classified. **(41)**

**r)** Pre-disaster situation, in which some risk of disaster exists, principally because the human population has placed itself in a situation of vulnerability. **(42)**

**s)** Event, phenomenon, process, situation, or activity that may potentially be harmful to the affected population and damaging to the society and the environment. Characterized by its location, magnitude, geometry, frequency or probability of occurrence, and other characteristics. **(43)**

**t)** Probability that a specific damaging event will happen within a specific area in a particular period of time. **(45)**

**u)** Source of danger whose evaluation encompasses three elements: risk of personal harm, risk of property damage, and the acceptability of the level or degree of risk. **(53)**

**v)** Condition or event that puts something or someone, in a position of loss or injury, or in a position of potential loss or injury. Landslide hazard results from a potential or actual landslide occurrence. **(56)**

**Head**:

**a)** The upper parts of the landslide along the contact between the displaced material and the main scarp. **(3)**

**b)** The upslope portion of a landslide. **(4)**

**c)** Upper part of a landslide along the contact between the displaced material and the main scarp (see Fig. 1). **(19, 34, 38)**

**Headscarp**:

**a)** Made by the outcropping of the main shearing surface in the crown area**. (19)**

**b)** The relatively steep slope, commonly arcuate in plan that forms the upper part of a landslide scar. **(37)**

**c)** Abrupt scarp at the head of a landslide; also see Main scarp. **(38)**

**Identification**: Process of finding, recognizing and fully describing hazard or risk. **(25)**

**Inactive**:

**a)** Landslide was not moving at time of visit or report**. (3)**

**b)** Landslide last moved during more than one annual cycle of the seasons ago. **(33)**

**c)** A qualifying descriptor (superscript) used to indicate that a material is not undergoing deposition at the present time. **(37)**

**d)** Landslide that has not moved within the last 12 months; can be sub-divided into dormant, abandoned, stabilized, relict, and repaired. **(38)**

**e)** Inactive landslides are those which have last moved more than one annual cycle of seasons ago. **(43)**

**Individual Risk**:

**a)** Risk of fatality or injury to an identifiable individual who lives or otherwise occupies an area affected, or potentially affected, by a landslide. **(13)**

**b)** Risk of multiple fatalities or injury to any identifiable (named) individual who lives within the zone affected by, or potentially affected by, a landslide, or who follows a particular pattern of life that might subject him or her to the consequences of the landslide. **(40)**

**c)** Addresses the safety of individuals who are most at risk in an existing or proposed development. **(66)**

**Initiation:** Recognize landslide risk scenario(s); identify stakeholders; establish scope, goals, methods of risk management, and risk management team and responsibilities. **(68)**

**Intensity**:

**a)** Measure of the effects of a hazard event at a particular place. **(8)**

**b)** Refers to the severity, or damage-causing potential of a natural process. The hazard intensity is determined by the peak deviation beyond the threshold. **(8)**

**c)** Refers to the damage-generating attributes of a hazard. **(8)**

**d)** Set of spatially distributed parameters related to the destructive power of a landslide; can be described quantitatively or qualitatively; can include maximum velocity, total displacement, differential displacement, depth of moving mass, peak discharge per unit width, kinetic energy per unit area. **(13)**

**e)** Subjective measure of the effect of an earthquake on local residents and construction. The intensity depends upon on the earthquake magnitude, duration of shaking, type of ground, water table, type and quality of construction. It is determined by people's perception of the ground shaking and the resulting damage. It is usually expressed by the Modified Mercalli Scale. **(14)**

**f)** Collection of physical parameters that describes the destruction or destructive potential of a landslide hazard, such as the downslope velocity, the thickness of the landslide debris and/or the impact forces. **(56)**

**Inventory**: Study of the location, classification, volume, activity, date of occurrence and other characteristics of landslides within an area. **(13)**

**Involuntary Risk**: Risk that typically is imposed on an individual or society. **(40)**

**Jökulhlaup**:

**a)** Glacial outburst flood, often the result of the breach of a glacial lake. **(6)**

**b)** Rapid discharge of water from an ice-dammed lake, often resulting from a volcanic eruption. **(22)**

**c)** Catastrophic floods resulting from the breaching of glacier-dammed lakes occur in many regions of the world with glaciers. The resulting floods are referred to as jökulhlaup, an Icelandic term meaning glacier burst. **(43)**

**d)** Eruptions that take place beneath ice sheets may cause meltwater floods (jökulhlaups): the increased water volume eventually raises the less dense ice hydrostatically and allows the sudden release of meltwater from beneath. **(44)**

**Lahar**:

**a)** Volcanic mud flow composed of unconsolidated volcanic debris and water. **(12)**

**b)** Mudslide induced by volcanic eruption either at the time of the eruption (by the mixing of hot gases, melted ice or water, and ash) or years later (by the failure of volcanic ash deposits in the presence of heavy rain). **(15)**

**c)** Catastrophic mudflow on the flank of a volcano. **(19)**

**d)** Mudflow associated with volcanic action or involving volcanic material. **(22)**

**e)** Debris flow or mudflow consisting largely of volcanic material. Lahars can be triggered during an eruption by interaction of erupting lava with snow, ice, lakes, streams or heavy rainfall. **(23)**

**f)** Mudflow containing rock debris and blocks of volcanic origin mixed with water; produced by the mixing of volcanic ejecta with ice or snow covering the volcano's slope. **(27)**

**g)** Mudflow or debris flow that originates on the slope of a volcano, usually triggered by heavy rainfall eroding volcanic deposits, sudden melting of snow and ice due to heat from volcanic vents, or breakout of water from glaciers, crater lakes, or lakes dammed by volcanic eruptions. **(35, 57)**

**h)** Debris flow related in some way to volcanic activity, either directly as a result of an eruption, or indirectly by the collapse of loose material from the flanks of a recent volcano. **(38)**

**i)** Using a Javanese word, volcanic mudflows are called lahars, and are classified as primary when they result directly from eruption and secondary if there are other causes. **(42)**

**j)** Flowing slurry of rock debris and water originating on the slopes of a volcano. The term may also mean the deposit of such a flow. **(43)**

**k)** Mass movement phenomena which consist of a mixture of water and volcanic ash: the high water content may be the result of heavy rainfall, or rapidly melting snow or glacial ice on which the ash falls, or even the bursting of a crater lake. **(44)**

**l)** Debris flows which are composed of volcaniclastic materials and drain from volcanoes. **(55)**

**Landslide**:

**a)** Mass of material that has moved downhill by gravity, often assisted by water when the material is saturated. The movement of soil, rock, or debris down a slope can occur rapidly, or may involve slow, gradual failure**. (1)**

**b)** Mass of soil and rock that moved downslope by gravity**. (4)**

**c)** General term for a mass movement landform and a process characterized by moderately rapid to rapid (greater than 30 cm per year) downslope transport by means of gravitational stresses, of a mass of rock and regolith that may or may not be water saturated. **(7)**

**d)** Any kind of moderate to rapid soil movement including lahar, mudslide, debris flow. A landslide is the movement of soil or rock controlled by gravity and the speed of the movement usually ranges between slow and rapid, but not very slow. It can be superficial or deep, but the materials have to make up a mass that is a portion of the slope of the slope itself. The movement has to be downward and outward with a free face. **(9)**

**e)** Movement of a mass of soil (earth or debris) or rock down a slope. **(13)**

**f)** Movement of a mass of soil, debris or rock down a slope. The term covers a wide variety of landforms all the result of gravitational forces. **(14)**

**g)** General term given to movement of material downslope in a mass. **(15)**

**h)** General term for rapid downslope movement of material under gravity. **(22)**

**i)** Downward movement of masses of soil or rock material. **(23)**

**j)** Movement of a mass of earth material downslope. **(27)**

**k)** Downward and outward movement of slope materials such as rock debris and earth, under the influence of gravity. **(32)**

**l)** Part of a slope that collapses and moves downwards under the influence of gravity. **(34)**

**m)** Any movement of rock, earth, or debris on slopes due to gravity. Besides sliding, movement may also include falls, topples, spreads, or flows. Landslides can be caused by rains, floods, earthquakes, and other natural causes, as well as man-made causes, such as grading, terrain cutting and filling, and excessive or inappropriate developments. Landslides can occur in developed areas, undeveloped areas, or any area where the terrain was altered for roads, houses, utilities, and even lawns and yards of homes. Landslides go through various stages of activity: active, reactivated, suspended, or inactive (such as dormant, abandoned, stabilized, or relict). **(35)**

**n)** General term for the downslope movement of large masses or earth material and the resulting landforms. **(37)**

**o)** Failure and movement of a mass of rock, sediment, soil, or artificial fill under the influence of gravity. **(43)**

**p)** Movement of a mass of rock, debris, or earth down a slope. **(46)**

**q)** Rapid movement of a mass of earth material due to slip surface failure (along which slide occurs), when the shearing stresses exceed the shear strength. **(47)**

**r)** Movement of rock, debris or earth down a slope. Landslides can be a result of a natural sequence of events and/or human activities. **(51)**

**s)** May be discrete, catastrophic events or, as with some large failures, very slow or episodically moving. **(55)**

**t)** Comprises almost all varieties of mass movements on slopes, including some, such as rock falls, topples, and debris flows, that involve little or no true sliding. **(56)**

**Landslide Inventory Map:** Show the distribution of past and active landslides, their relative activity, landslide density and/or geomorphic attributes, within an area. Some geomorphic attributes include slope, slope aspect, bedrock lithology and structure, soil type, depth of overburden, moisture content and geomorphic processes such as gullying and soil erosion. Each landslide is typically mapped as a geographically referenced polygon; small landslides can be represented by a geographically referenced point. Depending on the scale, other features such as fissures and grabens can also be mapped. If possible, each landslide should be assigned a landslide type and, where possible, other information should be included such as date of occurrence, state of activity and approximate volume. **(65)**

**Landslide Risk Evaluation:** Compares landslide risks, as determined from the risk analysis, against risk tolerance or risk acceptance criteria to guide the design and approval of proposed development and to prioritize treatment and monitoring efforts for existing development that is

or could be exposed to a landslide. In situations where consequences are not considered, the process is technically *hazard evaluation*. Landslide risk tolerance and risk acceptance criteria are more broadly referred to as landslide safety criteria. The combined process of risk identification, risk analysis and risk evaluation is referred to as risk assessment. **(66)**

**Landslide Risk Map:** Show the spatial distribution of the susceptibility of an area to landslides and also consider the effects on the elements at risk from those landslides. In other words, they communicate where landslides can initiate, the likelihood or probability of their occurrence and the consequences. Risk maps are used for land use and resource planning as well as planning and prioritizing landslide treatment, and they are typically the final product of a mapping project. **(65)**

**Landslide Susceptibility Map:** Show the spatial distribution of the susceptibility of an area to landslides. They communicate where landslides can initiate, and the likelihood or probability of their occurrence. Other characteristics of potential landslides events, such as type of landslide, magnitude (geographic extent, volume or peak discharge) and intensity, can also be included, but those characteristics are typically applied as a stepping stone to risk maps. Since a variety of landslide types can occur in an area, the type or types of landslide movement should also be specified. Susceptibility maps are derivative maps, interpreted from one or more inventory maps and additional information. **(65)**

**Landslip**: Former term for landslide; not a recommended term.

**Lateral Spread**: see Spread.

**a)** Used to describe the lateral extension of a cohesive rock or soil mass over a deforming mass of softer underlying material in which the controlling basal shear surface is often not well-defined. **(19)**

**b)** Lateral extension of a fractured mass of bedrock or surficial material; movement is predominantly horizontal. **(20)**

**c)** Movement of a landslide that spreads out laterally as it moves downhill. **(22)**

**d)** Slope movement characterized by the lateral extension of a more rigid mass over a deforming one of softer underlying material in which the controlling basal shear surface is often not well-defined. **(29)**

**e)** Result of the nearly horizontal movement of geologic materials, distinctive because they usually occur on very gentle slopes. The movement is caused by liquefaction triggered by rapid ground motion, such as that experienced during an earthquake or by slow chemical change in the pore water and mineral constituents of the ground. **(34, 35)**

**f)** Type of gravitational (mass movement) process in which movement in dominantly lateral extension accompanied by shear or tensile fractures. **(37)**

**g)** Liquefaction may cause lateral spreads, which commonly occur over distances of 3-5m on slopes of 0.3-3$^{o}$, though earthquakes of long duration can cause spreading of 30-50m on slopes of similar angle. **(42)**

**h)** Involves extension of a slab of earth material above a nearly flat shear plane. The moving slab may subside, rotate, disintegrate or flow. **(43)**

**i)** Failures by lateral spreading are special classes of slump which are virtually confined to clay-rich sediments deposited in the shallow seas and lakes around the edges of ice-sheets. **(55)**

**j)** Dominated by lateral extension of the ground accompanied by shear or tensile forces, and a general subsidence of the ground surface. They generally occur relatively slowly. **(56)**

**k)** Often occur on very gentle slopes and result in nearly horizontal movement of earth materials. Lateral spreads usually are caused by liquefaction, where saturated sediments (usually sands and silts) are transformed from a solid into a liquefied state, usually triggered by an earthquake. **(57)**

**Length of Centre Line ($L_{cl}$)**: Distance from the crown to the tip of landslide through points on original ground surface equidistant from lateral margins of surface of rupture and displaced material (see Fig. 2). **(38)**

**Length of Displaced Mass ($L_d$)**: Minimum distance from the top to the tip of a landslide (see Fig. 2). **(35)**

**Length of Rupture Surface ($L_r$)**: Minimum distance from the crown to the toe of the surface of rupture of a landslide (see Fig. 2). **(19, 38)**

**Level of Hazard or Risk**:

**a)** Magnitude of a risk or combination of risks, expressed in terms of the combination of consequences and their likelihood. **(25)**

**b)** Magnitude of a hazard or risk, expressed in terms of probability or likelihood (for hazard) and in terms of probability or likelihood and consequences (for risk). **(40, 68)**

**Likelihood**:

**c)** Chance of an event occurring; a qualitative description of probability of a landslide; also see Frequency and Probability. **(13)**

**d)** Chance of something happening. **(25)**

**e)** Used as a general description of probability or frequency. Can be expressed either qualitatively or quantitatively. **(34)**

**f)** Used to provide a qualitative estimate of probability, referred to as a probability rating. Likelihood estimates are typically expressed using relative qualitative terms, such as very low to very high or very unlikely to almost certain. Qualitative terms must be defined to avoid ambiguity. **(40)**

**g)** Chance of a landslide occurring, whether defined qualitatively or quantitatively; objectively or subjectively, typically likelihood is a qualitative estimate and probability is a quantitative estimate of the chance. **(68)**

**Long-term Preparedness**: Mitigation efforts that are developed to reduce or eliminate any risk to human life or property from natural hazards and their effects, over a substantially long period of time. **(35)**

**Main Body**: Part of the displaced material of a landslide that overlies the surface of rupture between the main scarp and the toe of the surface of rupture (see Fig. 1). **(3, 19, 34, 38)**

**Main Scarp**:

**a)** Steep surface on the undisturbed ground at the upper edge of the landslide, caused by movement of the displaced material away from the undisturbed ground. It is visible part of the surface of rupture. **(3, 19)**

**b)** Steep surface on the undisturbed ground around the periphery of the slide, caused by the movement of slide material away from undisturbed ground. The projection of the scarp surface under the displaced material becomes the surface of rupture**. (34)**

**c)** Steep surface of undisturbed material at the upslope extent of a landslide; caused by movement of the displaced material away from the undisturbed ground; the visible part of the surface of rupture (see Fig. 1); also see Headscarp. **(38)**

**Management**: Process of hazard or risk assessment and control or treatment. **(13)**

**Marginal**: Inactive landslide, between preparatory and active, where a trigger can initiate movement.

**Minor Scarp**: Steep surface on the displaced material of a landslide produced by differential movements within the displaced material (see Fig. 1). **(3, 19, 38)**

**Mitigation**:

**a)** Lessening of the potential adverse impacts of physical hazards (including those that are human-induced) through actions that reduce hazard, exposure, and vulnerability. **(1)**

**b)** Strategy on actions and/or interventions focusing on long-term goals and objectives to prevent adverse effects of natural hazards and/or potentially harmful processes. **(8)**

**c)** Either activity directed towards eliminating or reducing the probability of occurrence of a disaster-producing event, or reducing the effects of those events that are unavoidable. **(8)**

**d)** Proactive strategy to gear immediate actions to long-term goals and objectives. **(8)**

**e)** Range of policy, legislative mandates, professional practices, and social adjustments that are designed to reduce or minimize the effects of earthquakes and other natural hazards on a community. **(8)**

**f)** Structural and non-structural measures undertaken to limit the adverse impact of natural hazards, environmental degradation and technological hazards. **(8)**

**g)** Structural and non-structural measures undertaken to limit the adverse impact of natural hazards, environmental degradation and technological hazards. **(10)**

**h)** Risk mitigation measures should be to reduce risk, to engineer out uncertainty in the risk and to provide a level of risk satisfying community expectations through the regulators criteria once properly implemented. **(13)**

**i)** Include alternative options by the adoption of:

a. Accepting the risk, which other mitigation measures are required.
b. Avoid the risk, such as relocation
c. Reduce the frequency of landsliding, by stabilization measures to control the initiating circumstances, either by drainage schemes, retaining structures and walls, or ground anchors.
d. Reduce the consequences, by provision of defensive stabilization measures, such as a boulder catch fence. **(13)**

**j)** Changes in an environment to minimize loss from a disaster. **(22)**

**k)** Lessening or limitation of the adverse impacts of hazards and related disasters. **(24)**

**l)** Structural and non-structural measures undertaken to limit the adverse impact of natural hazards, environmental degradation and technological hazards. **(26)**

**m)** Human measure to reduce the sources or enhance the sinks of greenhouse gases. **(26)**

**n)** The minimization action of the effects of a natural hazard; it has physical, engineering, and social aspects. **(27)**

**o)** In disaster risk management means the structural and non-structural measures undertaken to limit the adverse impact of natural hazards, environmental degradation and technological hazards. **(28)**

**p)** Sustained action taken to reduce or eliminate the long term risk to human live and property from natural hazards and their effects. Emphasis on long term risk distinguished mitigation from actions geared primarily to emergency preparedness and short term recovery. **(35)**

**q)** Measures aimed at reducing the risk, impact or effects of a disaster or threatening disaster situation. **(32, 39)**

**r)** Structural and non-structural measures undertaken to limit the adverse impact of natural hazards, environmental degradation and technological hazards. **(33)**

**s)** Planning and execution of measures designed to reduce the risk to acceptable or tolerable levels. **(43)**

**t)** Long-term actions that reduce the risk of natural disasters, such as constructing dams and prohibiting people from building homes or businesses in high-risk areas. **(49)**

**Moderate**: Slope movement with velocity less than 1.8m/hour (0.5mm/sec) and greater than 13m/month ($5x10^3$mm/sec). **(38)**

**Moist**: Material that contains some water but no free water, and may behave as a plastic solid but does not flow. **(38, 63)**

**Monitoring**:

**a)** Is a key function of the risk management program, which has four primary functions:

1. To detect and adapt to changing circumstances
2. The ensure that the risk control and risk financing options are achieving the results expected of them
3. The ensure proper implementation of control, financing, and communication strategies
4. To verify the correctness of assumptions used in the various analyses. **(16)**

**b)** When monitoring for changes in the system, six broad categories of issues should be considered. They are: the environment, the factor exposed to the loss, the hazard causing the loss, the acceptability of the loss, the stakeholders, and new technology **(16)**

**c)** Continual checking, supervising, critically observing or determining the status in order to identify change from the performance level required or expected **(25)**

**Moving**:

**a)** Activity where the displaced material continues to move without any visible change in the rupture surface and the volume of the displaced material. **(5)**

**b)** Landslide continues to move but its rupture surface (s) shows no obvious indications of movement. **(33)**

**Multiple**:

**a)** Landslide shows repeated development of the same type of movement**. (19)**

**b)** The same type of failure is repeated within a landslide. For example, the landslide is composed of several rotational slumps. **(33)**

**c)** Activity where a landslide shows repeated development of the same type of movement. **(38)**

**Natural Landslide**: The movement of earth material caused by geological, morphological or physical triggers. Such triggers could be intense rainfall, rapid snowmelt, water-level change, volcanic eruptions, earthquakes, weak or sensitive materials, and vegetation removal (by forest fire, or drought). **(21)**

**On the slope**: The area of a location that is experiencing ground movement, marked by diagonal tension and shear cracking. It is the main body of a slope. **(38)**

**Original Ground Surface**: Surface of slope that existed before a landslide occurred (see Fig. 1). **(19, 38)**

**Partial Risk**:

**a)** Combination of the probability of a (hazardous) landslide and probability of the landslide affecting the site of an element at risk at the site when the landslide occurs; does not consider vulnerability; $P_{(HA)} = P_{(H)} \times P_{(S:H)} \times P_{(T:S)}$. **(40)**

**b)** Combination of the first two terms, PH * PS:H. Partial risk is also known as encounter probability. **(66)**

**Passive**:

**a)** Passive measures try to contain an effect or reduce the impact of a natural hazard, without an active influence to the process (e.g. avoidance from endangered areas, spatial planning, contingency planning). **(3)**

**b)** Form of mitigation that requires no design engineering; includes avoidance, land use regulations, education and warning systems. **(38)**

**Permafrost**:

**a)** Ground (soil or rock and included ice and organic material) that remains at or below )0C for at least 2 consecutive years. **(1)**

**b)** (i) Permanently frozen subsurface material underlying the solum; (ii) perennially frozen soil horizon where temperature remains below 0°C throughout the year and in which Cryosols form. **(7)**

**c)** Ground condition of soil or rock that remains at or below 0°C for more than two years. **(11)**

**d)** Permanently frozen ground, i.e. for a continuous period of at least two years. Discontinuous permafrost is used when permafrost breaks up and merges with seasonally frozen ground. **(19)**

**e)** Sediment that remains frozen for at least two consecutive years. **(22)**

**f)** Ground conditions of either soil or rock that remains at or below $0^{o}$C for long periods. **(30)**

**g)** Material in which temperature has remained below 00C continuously for at least 2 years, regardless of type of material or water content; a thermal condition. **(37)**

**h)** Ground that remains at or below $0^{o}$C for 2 years or more. **(43)**

**Potential**: Any of several different scalar quantities, each of which involves energy as a function of position or of condition (b) The amount of work required to place a unit charge, unit pole, or unit mass at a given position, usually with respect to infinity. (c) A function from which a quantity can be determined by specified mathematical operations, as a potential field from which seismic displacement, velocity, etc. can be ascertained by differentiation. **(6)**

**Preparatory Causes**:

**a)** Reason(s) that a landslide occurred at a particular location and time; mechanism(s) that put a landslide into a preparatory state of activity; can include geological factors (e.g. sensitive materials, joints and fissures), geomorphological factors (e.g. slope angle, erosion), physical factors (e.g. rainfall, earthquake) and factors associated with human activity (e.g. addition of a load or excavation).

**b)** Possible causes can be: relief, geological conditions, hydrogeology, climate**. (3)**

**Probability**:

**a)** Probability of an event has been defined as its long-run relative frequency. It has also been thought of as a personal degree of belief that a particular event will occur (subjective probability). P(E) = number of outcomes corresponding to event E / total number of outcomes . **(8)**

**b)** A risk event represents a future event that may occur. When assessing the probability a risk may occur, it is technically assessing a conditional probability; that is, $0 < \text{Prob}(A|B) < 1$ where, A is the Associated Risk Event and B is the Condition Present**. (8)**

**c)**

1) Estimate of the degree of certainty between 0 (impossible) and 1 (certain) of an event occurring; also see Likelihood and Frequency; can be statistical or subjective; or
2) Probability of occurrence of a (hazardous) landslide; can be statistical or subjective; $P_{(H)}$. **(13)**

**d)** The likelihood of a specific outcome. **(34)**

**e)** Probability of landslide occurrence is an estimate of the chance for a landslide to occur. **(40)**

**f)** Probability of occurrence (P) is the chance or probability that a landslide hazard will occur. It can be expressed in relative (qualitative) terms or probabilistic (quantitative) terms**. (56)**

**Qualitative Risk Analysis**: Analysis that uses descriptive words or numeric rating scales to describe likelihood, vulnerability and consequences. **(13)**

**Quality Management:** Includes Quality Assurance/Quality Control (QA/QC), peer review and appropriate filing of both hard copy and electronic project files and retention of those files for an appropriate number of years. **(67)**

**Quantitative Risk Analysis**: Analysis based on numerical values of probability, vulnerability and consequences. **(13)**

**Reactivated**:

**a)** Landslide has resumed movement after being inactive. The period of inactivity could be tens, hundreds, or thousands of years. **(33)**

**b)** Landslide that is again active after being inactive. **(38)**

**c)** Landslide which is again active after being inactive may be called reactivated. **(43)**

**Rapid**: Slope movement with velocity greater than 1.8m/hour (0.5mm/sec). **(38)**

**Relict**:

**a)** Landslide is very old (thousands or millions of years) and occurred under environmental conditions different than those that presently prevail**. (33)**

**b)** Slide that is not active and for which, the driving mechanism or climatic conditions no longer exist. **(36)**

**c)** Inactive landslide that developed under climatic or geomorphological conditions considerably different from those at present. **(38)**

**d)** Landslides which have clearly developed under different geomorphological or climatic conditions perhaps thousands of years ago can be called relict. **(43)**

**Remediation**: A two-step approach recommended for landslides remediation which avoids the common pitfall of developing a "one solution fits all" mentality. The basic questions that need to be addressed include: 1. What was the cause of the landslide? and 2. What is the amount of remediation needed to maintain stability for reasonably foreseeable future conditions? **(17)**

**Repaired**: Inactive landslide that has been temporarily protected from its original cause(s) by artificial remedial measures.

**Retrogressing**:

**a)** The rupture surface is extending in a direction opposite to the movement of displaced material. **(33)**

**b)** Activity where the surface of rupture extends in the direction opposite to the movement of the displaced material. **(38)**

**Residual**:

**a)** Risk or danger of an action or an event, a method or a (technical) process that, although being abreast with science, still conceives these dangers, even if all theoretically possible safety measures would be applied (scientifically conceivable measures.) **(3)**

**b)** Risk remaining after all risk control strategies have been applied. **(16)**

**c)** Risk that remains in unmanaged form, even when effective disaster risk reduction measures are in place, and for which emergency response and recovery capacities must be maintained. **(24)**

**d)** Hazard or risk remaining after mitigation. **(25)**

**e)** Risk remaining after risk treatment; includes unidentified risk. **(68)**

**Risk**:

**a)**

1. Combination of the likelihood or probability of occurrence of a landslide and the consequences of a landslide occurring;
2. Specific risk is the risk of loss or damage to a specific element at risk resulting from a specific hazardous affecting landslide; partial risk that also considers vulnerability; $R_{(S)} = P_{(HA)} \times V_{(L:T)} = P_{(H)} \times P_{(S:H)} \times P_{(T:S)} \times V_{(L:T)} = P_{(H)} \times C$; or
3. Total risk is the risk of loss or damage to all specific elements at risk from all specific hazardous affecting landslides.

**b)** Describes the probability a condition or process can lead into an event with a negative effect (damage). Especially "risk" specifies the qualitative and quantitative characteristic from a possible damage. It describes particularly the extent of losses and can be numbered as the product of probability and damage potential. **(3)**

**c)** Combination of the probability (or frequency) of occurrence of a natural hazard and the extent of the consequences of the impacts. A risk is a function of the exposure and the perception of potential impacts as perceived by a community or system**. (8)**

**d)** Technical definition including two variables – the probability of occurrence of a specific instance of damage, and the extent of that damage. Nevertheless social science perspective focuses on the aspects of societal and psychological risk experience and risk perception, while socio-economic approaches focus on risks to livelihood security and the satisfaction of basic needs. **(8)**

**e)** Risk is a function of probability, exposure and vulnerability. Often, in practice, exposure is incorporated in the assessment of consequences, therefore risk can be considered as having two components — the probability that an event will occur and the impact (or consequence) associated with that. Risk = Probability x Consequence. **(8)**

**f)** Relative degree of probability that a hazardous event will occur. The probability of harmful consequences or expected losses (deaths, injuries, property, livelihoods, disruption of economic activity or environmental damage) resulting from interactions between natural or human-induced hazards and vulnerable conditions. Based on mathematical calculations, risk is the product of hazard and vulnerability. Conventionally, risk is expressed by the notation: Risk = Hazards x Vulnerability. Some disciplines also include the concept of exposure to refer particularly to the physical aspects of vulnerability. **(8)**

**g)** Expected losses (of lives, persons injured, property damaged and economic activity disrupted) due to a particular hazard for a given area and reference period. Based on mathematical calculations, risk is the product of hazard and vulnerability: Risk = Hazard x Vulnerability. **(8)**

**h)** Expected losses (of lives, persons injured, property damaged and economic activity disrupted) due to a particular hazard of a certain intensity for a given area and reference period. Risk = Hazard x Expected Losses Expected Losses = Vulnerability x Value. **(8)**

**i)** Probability and severity of an adverse effect / event occurring to man or the environment following exposure, under defined conditions, to a risk source(s). [The probability of adverse effects caused under specified circumstances by an agent in an organism, a population or an ecological system]. **(8)**

**j)** Expected losses (of lives, persons injured, property damaged and economic activity disrupted) due to a particular hazard for a given area and reference period. Based on mathematical calculations, risk is the product of hazard and vulnerability. **(9)**

**k)** Probability of harmful consequences, or expected loss (of lives, people injured, property, livelihoods, economic activity disrupted or environment damaged) resulting from the interactions between natural or human induced hazards and vulnerable/capable conditions. Conventionally risk is expressed by the equation Risk= Hazards x Vulnerability/Capacity. **(10)**

**l)** Measure of the probability and severity of an adverse effect to health, property or the environment. Risk is often estimated by the product of probability x consequences. However, a more general interpretation of risk involves a comparison of the probability and consequences in a non-product form. **(13)**

**m)**Product of a hazard (as in geological hazard) multiplied by the consequence (as in impact on social, environmental and resource values) of that hazard occurring. If there is no hazard or no consequence, then there is no risk. **(14)**

**n)** Chance of injury or loss as defined as a measure of the probability and severity of an adverse effect to health, property, the environment, or other things of value. **(16)**

**o)** Chance or potential for something to happen. **(22)**

**p)** Combination of the probability of an event and its negative consequences. **(24)**

**q)** Probability of harmful consequences, or expected loss of lives, people injured, property, livelihoods, economic activity disrupted (or environment damaged) resulting from interactions between natural or human induced hazards and vulnerable conditions. **(26)**

**r)** Function of probability and magnitude of different impacts. **(26)**

**s)** Means the possible losses arising as a result of ground movement, i.e. the community is at risk from ground movement. **(31)**

**t)** Anticipated number of lives in danger, damage to property and disruption of economic activity due to a particular natural phenomenon. **(32)**

**u)** Chance of something happening that will be an impact. A risk is often specified in terms of an event or circumstance and the consequences that may flow from it. **(34)**

**v)** Expected number of lives lost, persons injured, damage to property and disruption of economic activity due to a particular natural phenomenon. **(39)**

**w)** Chance of injury or loss as defined as a measure of the probability and the consequence of an adverse effect to health, property, the environment, or other things of value. **(40)**

**x)** Results arising out of the interaction of hazard, vulnerability and exposure. This interaction makes for the possibility of harmful consequences or expected losses (economic, physical, social and environmental) amid certain sectors of society. A risk exists when a possibility of such losses arises as a result of all three factors coalescing. If one of these factors is missing, risk is nil**. (41)**

**y)** Risk constitutes a multidisciplinary research field. In the context the term "risk" is defined differently by various disciplines and fields of work. In natural hazard and disaster risk reduction research, risk is most commonly defined as the result of the interaction of a hazard (e.g., flood, hurricane, earthquake, etc.) and the vulnerability of the system or element exposed, including the probability of the occurrence of the hazard phenomena. **(43)**

**z)** Risk= f(hazard, exposure, vulnerability, coping capacity). **(45)**

**Risk Analysis:** For each landslide risk scenario, estimate likelihood or probability, factor of safety, or slope deformation; travel path and distance; consequences; level of risk. **(68)**

**Risk Assessment:** Combination of risk identification, risk analysis and risk evaluation. It is implied that risk assessment and risk treatment are reiterative. **(68)**

**Risk Evaluation:** For each landslide risk scenario compare risk estimates against tolerable risk or acceptable risk criteria; prioritize risk treatment and monitoring. **(68)**

**Risk Identification:** Confirm landslide risk scenario(s); identify study area and time frame; identify, inventory and characterize landslide(s) and elements at risk; collect and review background information. **(68)**

**Risk Scenario:** Sequence of events with an associated likelihood or probability of occurrence and consequences. **(68)**

**Risk Treatment**: The risk treatment step of the risk management process involves identifying a range of risk possible treatment options. Such options should consider reducing the landslide hazard (reducing the likelihood or probability of occurrence, increasing the factor of safety, or reducing the slope deformation), modifying the travel path or travel distance, or modifying the elements at risk by modifying the spatial probability, temporal probability and/or vulnerability. In certain circumstances doing nothing can be considered an option. **(68)**

**Rock**:

**a)** Solid aggregate of minerals. **(12)**

**b)** Hard or firm mass of inorganic material that was intact and in situ before the initiation of a landslide. **(13)**

**c)** Mass of interlocking or cemented mineral grains**. (22)**

**d)** Material composed of mineral grains and crystals tightly bound together by cements and interlocking of crystals; it is hard, elastic substance which does not significantly soften on immersion in water; in a mass it is a discontinuous material with joints and other partings which divide the mass into discrete blocks; it is the partings which largely control the resistance of a rock mass, to the forces acting upon it, and not the strength of grains, crystals, or cementing materials holding blocks together. **(55)**

**e)** Natural aggregate of minerals that cannot be readily broken by hand and that will not disintegrate on a first wetting and drying cycle. For the purpose of landslide classification, rock is not subdivided, but can be classified with respect to its geological origin and lithology. With respect to landslides, an important differentiation can be made between intact rock and rock mass – rock material separated by discontinuities and affected by weathering. For more information on the engineering classification of rock, refer to the Canadian Foundation Engineering Manual (Canadian Geotechnical Society, 2006). The International Standard (ISO, 2003) suggests a standard to classify rocks by genesis, structure, grain size and mineralogy, among other criteria. **(63)**

**Rotational Slide**:

**a)** Sometimes called slumps because they move with rotation. **(2)**

**b)** Landslide on which the surface of rupture is curved upward (spoon-shaped) and the slide movement is more or less rotational about an axis that is parallel to the contour of the slope. The displaced mass may, under certain circumstances, move as a relatively coherent mass

along the rupture surface with little internal deformation. The head of the displaced material may move almost vertically downward, and the upper surface of the displaced material may tilt backwards toward the scarp. If the slide is rotational and has several parallel curved planes of movement, it is called a slump. **(3)**

**c)** Downward-and-outward movement of a mass on top of a concave-upward failure surface. **(12)**

**d)** Type of landslide movement in which the movement takes place on a well-defined, curved shear surface, concave upward, producing a backward rotation in the displaced mass. **(14)**

**e)** Landslide in which the mass rotates as it slides on a basal slip surface. Also called a slump. **(22)**

**f)** More or less rotational movement, about an axis that is parallel to the slope contours, involving shear displacement visible or may reasonably be inferred. **(29)**

**g)** Landslide in which the surface of the rupture is curved concavely upward (spoon shaped) and the slide movement is more or less rotational about an axis parallel to the contour of the slope. A "slump" is an example of a rotational slide. **(34, 35)**

**h)** Landslide in which the surface of rupture is curved concavely upward and movement is roughly rotational about an axis parallel to the ground surface and transverse across the landslide. **(38)**

**i)** As discussed, the classic form of landslide is the rotational slide, which has a curved surface of rupture and produces slumps by backward slippage. **(42)**

**j)** Involves translation of rock or sediment along a curved, concave-upward failure surface, producing what are termed slumps. **(43)**

**k)** Also referred to as slumps, involve movements along a curved failure plane. Often the failure plane did not exist before movement occurred. Rotational slides usually involve relatively few distinct rock or soil units. **(56)**

**l)** Surface of rupture is curved concavely upward (spoon-shaped), and the slide movement is more or less rotational. A slump is an example of a small rotational landslide. **(57)**

**Run-out**:

**a)** Extension of a landslide body outside the source area, downslope or down a valley. **(19)**

**b)** Down-slope extent of the displaced material. **(34)**

**c)** Maximum travel distance of a landslide. **(53)**

**Run-up**: Maximum height reached by a landslide mass. **(53)**

**Sackung:** Creeping, flow type deep seated gravitational deformation affecting densely jointed or stratified hard rocks. **(3)**

**Short-term Preparedness**: Include the actions geared primarily towards emergency preparedness and short term recovery from natural hazards and their effects. **(35)**

**Side Scarp**: also *see* Flank

**a)** A steep surface on the undisturbed ground that defines the lateral margins (flank) of the slide, caused by the movement of slide material away from undisturbed ground. Sometimes referred to as "lateral scarp". **(34)**

**Single**:

**a)** Single landslide is a single movement of displaced material. **(19)**

**b)** Movement confined to a single block or element within the slope**. (33)**

**c)** Activity where a landslide exhibits only one type of movement (fall, topple, slide, spread, or flow). **(38)**

**Size:** Unlike earthquake magnitude, which is related to the energy released by a seismic event, there is no agreed upon definition of landslide magnitude, and use of the term is discouraged. Alternatively, the size of a landslide can be expressed in terms of: 1) volume of displaced material, 2) areas affected (non-overlapping area of depletion and area of accumulation), or 3) peak discharge where a confined flow is involved. Each approach has its advantages, disadvantages, specific applications and limitations. **(63)**

**Slide**:

**a)** One of the most common forms of failure and can be subdivided into translational and rotational slides. Slides are most common when the toe of the slope is undercut. They have a moderate rate of movement and the coherence of material is retained, moving largely intact or in broken pieces. **(2)**

**b)** Slide is a downslope movement of a soil or rock mass occurring on surfaces of rupture or on relatively thin zones of intense shear strain. Movement does not initially occur simultaneously over the whole of what eventually becomes the surface of rupture. **(3)**

**c)** Gravity-pulled mass movement on top of a failure or slide surface; a landslide. **(12)**

**d)** Type of landslide movement in which the soil or rock moves downslope relatively intact by sliding as opposed to flowing or falling. Also see planar slide and rotation slide**. (14)**

**e)** Slope movement by which the material is displaced more or less coherently along a recognisable or less well-defined shear surface or band. Slide could be rotational (the sliding surface is curved) or translational (the sliding surface is more or less straight). In some cases a slide can change into a mudslide or slump-earthflow, especially on steep slopes, in highly tectonized clays or silty formations. **(29)**

**f)** Mass displaced on one or more recognisable surfaces, which may be curved or planar. **(34)**

**g)** Downslope movement of a soil or rock mass occurring dominantly on surfaces of rupture or relatively thin zones of intense shear strain; use as a diminutive of 'Landslide' not recommended. **(38)**

**h)** Involve the downslope translational movement of rock or sediment along a discrete surface. They are subdivided into translational and rotational types, although many slides are complex phenomena, involving both types of movements. **(43)**

**i)** Slide movements were divided into three classes: block, multiple retrogressive and rotational. **(48)**

**j)** Movement consists of shear train and displacement along one or several surfaces that are visible or may reasonably be inferred, or within a relatively narrow zone. **(54)**

**k)** Movement along one or more distinct surfaces. Slides are subdivided into "rotational slides" and "translational slides", depending upon the shape of the failure plane**. (56)**

**l)** Many types of mass movement are included in the general term "landslide". The two major types of landslides are rotational slides and translational landslides. **(57)**

**m)**Downslope movement of a soil or rock mass on a distinct slide or shear surface, occurring dominantly on the surface of rupture or relatively thin zones of intense shear strain. **(58)**

**n)** Downslope movement of a soil or rock mass on rupture surfaces or relatively thin zones of intense shear strain. Movement is usually progressive, that is it does not initially occur simultaneously over the entire, of what eventually will be, the rupture surface. It propagates from an area of local rupture. Often the first signs of movement are cracks in the ground surface along which the main scarp of the slide will likely form. The rupture surface, in two dimensions can be described as linear, circular or curvilinear (curved but not circular). The displaced material can slide beyond the toe of the rupture surface and cover the original ground surface. That surface then becomes a surface of separation. **(63)**

**Slope Instability**:

**a)** The potential or actual movement of material on a slope. **(34)**

**Slope Stability Analysis**: Analysis of static and dynamic stability of engineered and natural slopes of soil and rock. **(38)**

**Slow**: Slope movement with velocity less than 13m/month ($5x10^{-3}$mm/sec). **(38)**

**Slump**:

**a)** Mass of soil and rock that moves along a curved failure surface with rotation but without internal deformation of the landslide material. **(4)**

**b)** Landslide above a curved failure surface. **(12)**

**c)** Tendency for some landslides to undergo rotation, with the greatest failure of material at the downslope end. **(15)**

**d)** Sliding of internally cohesive masses of bedrock or surficial material along a slip plane that is concave upward or planar. **(20)**

**e)** Short, downslope movement of a coherent mass of loosely consolidated soil or rock; not a recommended term. **(21)**

**f)** Landslide characterized by a shearing and rotary movement of a cohesive mass of rock or earth along a concave, upwardly curved slip surface; rotational slump. **(37)**

**g)** Name given to a slide when the underlying failure surface is curved rather than planar. The motion of a slump is rotational, so that portions of the slide drop and rise with respect to the adjacent stable slopes. It is more properly referred to as a rotational slide. **(43)**

**h)** Movements of coherent sediment masses over discrete basal shear planes. They terminate upslope in headscarps, with relief of a few to hundreds of meters. **(45)**

**i)** Have curved failure planes and involve rotational movement of the soil mass. **(55)**

**j)** Usually located along river banks, road cuts or steep valley sides. They can involve the displacement of one or more rotational blocks of weak, predominantly fine grained soil. They can occur extremely slowly too rapidly, all at once, or slowly but progressively. **(56)**

**Societal Risk**:

**a)** Risk of multiple injuries or fatalities, financial, environmental, and other losses from a landslide, the burden of which society has to carry. **(13)**

**b)** Addresses the potential societal losses as a whole caused by total potential losses of people in the community from a hazard event. Societal risk estimates are typically presented on graphs showing the expected frequency of occurrence and cumulative number of fatalities, referred to as F-N curves. **(66)**

**Soil**:

**a)** Surface layers of sediment, organic matter, and decomposing bedrock. **(12)**

**b)** Aggregate of solid, typically inorganic particles that either was transported or was formed in situ by weathering of rock; subdivided into earth and debris. **(13)**

**c)** All unconsolidated earthy material overlying bedrock. Broadly classified by grain size into gravel, sand, silt and clay. From an engineering viewpoint, soil can be broken down by hand, or during one wetting and drying cycle. **(14)**

**d)** All loose (unconsolidated) material between the ground surface and the underlying bedrock, including stream, river, and glacial sediments. **(32)**

**e)** Natural medium for growth of land plants; the result of the combined effects of physical, chemical and biological processes. **(37)**

**f)** Naturally occurring loose or soft deposit formed at the surface of the Earth; it is weakened or softened by immersion in water; it may be the result of physical, chemical, and biological processes acting to produce an organic-rich material (or solum) with distinctive horizons (layers) at shallow depths. **(55)**

**g)** An aggregate of solid minerals and rocks that is either fragmentary or can be readily separated by agitation in water. It has either been transported or formed by the weathering of rock in place. Gases or liquids fill the pores and form part of the soil. For the purpose of landslide classification, soil is divided into debris and earth. Debris has 20% to 80% of the particles larger than 2 mm. Earth has 80% or more of the particles smaller than 2 mm. Earth is further subdivided into sand, silt and clay by grain size and plasticity. For more information on the engineering classification of soil, refer to the Canadian Foundation Engineering Manual (Canadian Geotechnical Society, 2006). **(63)**

**Spatial Probability**: The potential of a landslide affecting the site of an element at risk; $P_{(S:H)}$. **(22)**

**Special Materials**: Materials that are associated with landslides or other earth movements. Such materials specific to earth movements could be materials including sensitive clays, permafrost

rich soils, weathered rock, highly fractured rock, etc. A special material can be any earth material that is indicative to landslides or any earth movement.

**Specific Risk**: *see* Risk (2)

**a)** Expected degree of loss due to particular natural phenomenon. **(32, 39)**

**b)** Risk of loss or damage to a specific element, resulting from a specific hazardous affecting landslide. (**40**)

**c)** Degree of loss likely to be caused by a particular natural phenomenon. It may be expressed as the product of natural hazard, H, times the vulnerability, V. **(42)**

**d)** Means the expected degree of loss due to a particular natural phenomenon. It may be expressed by the product of H times V. **(55, 60)**

**e)** Product of the annual probability of occurrence and the vulnerability ($R_s$- $P_a$ x V) for a specific element at risk. **(56)**

**Spread**:

**a)** Phenomenon is characterised by the gradual lateral displacement of large volumes of distributed material over very gentle or flat terrain. Failure is caused by liquefaction which is the process when saturated loose sediment with little or no cohesion such as sands or silts are transformed into a liquid-like state. This process is triggered by rapid ground motion most commonly during earthquakes **(2)**

**b)** An extension of a coherent soil or rock mass combined with the subsidence of the fractured mass of cohesive material into softer underlying material. The surface of rupture is not a surface of intense shear. **(3)**

**c)** Extensional movement of a cohesive soil or rock mass combined with a general subsidence of the fractured mass of material into a softer underlying material; surface of rupture is not a surface of intense shear; spreads can result from liquefaction or flow (and extrusion) of the softer material. **(38)**

**d)** Lateral spreading is characterised by the low-angled slopes involved and the unusual form and rate of movement. A spread is an extension of a cohesive soil or rock mass combined with a general subsidence of the fractured mass of cohesive material into softer underlying material. The rupture surface of intense shear. Spreads may result from liquefaction or flow (and extrusion) of the softer material. **(58)**

**e)** Extension of a cohesive rock or soil mass combined with a general subsidence of the fractured material. The rupture surface is not a surface of intense shear. Spreads can result from liquefaction or flow (and extrusion). The fractured mass can also translate, rotate,

liquefy or flow. This mode of movement is complex, but sufficiently common to warrant its own movement mode. **(63)**

**Stabilized**:

**a)** Landslide has been active but is now stabilised by remedial action. **(3)**

**b)** Condition of stability has been created**. (33)**

**c)** Inactive landslide that has been permanently protected from its original causes by artificial remedial measures. **(38)**

**d)** If the toe of the slope had been protected against erosion by bank armoring or other artificial remedial measures have stopped the movement, the landslide can be described as stabilized. **(43)**

**Stakeholders:** Person or organization that can affect, be affected by, or perceive themselves to be affected by a landslide, or by associated decisions or activities; includes appropriate government agencies. **(68)**

**State of Activity**: Terms that describe the timing of landslide movements (active, reactivated, suspended, inactive, dormant, abandoned, stabilized, relict, preparatory, marginal, and repaired). **(38, 63)**

**Style of Activity**:

**a)** Terms that describe the manner in which different movements contribute to a landslide (complex, composite, multiple, successive, single). **(38)**

**b)** Way in which different movements contribute to the landslide, the style of the landslide activity, can be described by terms from Varnes (1978, p.23). **(43, 63)**

**Subaerial**: Said of conditions and processes, such as erosion, that exists or operates in the open air on or immediately adjacent to the land surface; or of features and materials, such as eolian deposits, that are formed or situated on the land surface. **(6)**

**Subaqueous**: Said of conditions and processes, or of features and deposits, that exist or are situated in or under water, esp. fresh water, as in a lake or stream. Generally used to specify a process that occurs either on land or under water, e.g. slumping, gravitational slides. **(6)**

**Subsidence**:

**a)** Sinking or settling of the ground surface caused when soil or rock collapses into a void. Subsidence can be natural (a sinkhole) or human induced (due to underground mining or pumping of petroleum or water). **(4)**

**b)** Vertical downward movement of the ground surface; frequently occurs in karst terrains or can be related to mining activities. **(6)**

**c)** Downward motion of the Earth's surface relative to a datum (e.g. the sea level). Subsidence is the motion of the Earth's surface as it shifts downward relative to a datum. Subsidence (dry) can be a result of: geological faulting, isostatic rebound, human impact (e.g. mining, extraction of natural gas) etc. Subsidence (wet) can be the result of: karst changes in soil water saturation, permafrost degradation (thermokarst) etc. **(9)**

**d)** Downward movement of the ground either slowly or catastrophically. **(12)**

**e)** Local or regional sinking or collapse of the land surface with little or no horizontal movement. **(14)**

**f)** Downward failure of the Earth's surface brought about mainly by removal of material from below. **(15)**

**g)** Settling of the ground in response to extraction of water or oil in subsurface soil and sediments, drying of peat, or formation of sinkholes. Subsidence of the ocean floors occurs by cooling of hot lithosphere. **(22)**

**h)** Sinking or collapsing of the ground surface normally due to poorly compacted soils or withdrawal of groundwater, oil, or gas. Mining and natural caverns also cause subsidence. **(35)**

**i)** Type of mass movement that involves the downward displacement of surface material caused by natural or artificial removal of underlying support (collapse) or by compression of soils (consolidation). **(42)**

**j)** Mainly vertical downward displacement of the Earth's surface generally due to insufficient support from beneath, a superimposed load, or a combination of both. It can arise from natural causes, human activities, or, often, by human activities destabilizing natural systems. **(43)**

**Successive**:

**a)** Landslide is the same type as a nearby, earlier landslide, but does not share displaced material or a rupture surface with it. **(19)**

**b)** One landslide succeeds another of the same type on the same slope but it does not involve the material displaced by the proceeding landslide nor its rupture surface. For example, a landslide composed of a succession of rotational slips. **(33)**

**c)** Activity where a landslide exhibits the same type of movement as a nearby, earlier landslide but does not share displaced material or a surface of rupture. **(38)**

**Surface of Rupture**:

**a)** Surface which forms (or which has formed) the lower boundary of the displaced material below the original ground surface. **(3)**

**b)** Surface that forms, or has formed, the lower boundary of the displaced material of a landslide below the original ground surface (see Fig. 1). **(19, 38)**

**Surface of Separation**:

**a)** Part of the original ground surface overlain by the foot of a landslide (see Fig. 1). **(19, 38)**

**b)** Surface separating displaced material from stable material but not known to have been a surface of which failure occurred. **(34)**

**Susceptibility**:

**a)** Areas that have the potential for occurrence of natural hazards (e.g. landslides, floods). These areas are determined by correlating some of potential factors that contribute to natural events, such as slope angle, lithology, land use, with the past distribution of the events. **(8)**

**b)** Propensity of a particular receptor to experience harm**. (8)**

**c)** Qualitative or quantitative analysis of the classification, volume (or area), and spatial distribution of landslides that exist or potentially can occur in an area; can also include a description of the velocity and intensity of the existing or potential landslide; a time frame is explicitly not taken into account. **(13)**

**d)** Being prone to. **(34)**

**e)** Means “the state of being susceptible” or “easily affected”. In the natural hazards terms, susceptibility is related to spatial aspects of the hazard. It refers to the tendency of an area to undergo the effects of a certain hazardous process (e.g., floods, earthquakes, tsunamis, subsidence, etc.) without taking into account wither the moment of occurrence or potential victims and economic losses. **(43)**

**f)** Degree of sensitivity of a community or system to potential impacts of hazards (see sensitivity). **(8)**

**Suspended**:

**a)** Landslide moved during the last annual cycle of seasons but is not moving at the present**. (33)**

**b)** Landslide that has moved within the last 12 months but is not active at present. **(38)**

**c)** Landslides which have moved within the last annual cycle of seasons but which are not moving at present are described as suspended. **(43)**

**Temporal Probability**:

**a)** Probability that the element at risk is in the affected area at the time of the landslide. **(13)**

**b)** Probability that an element at risk is at the site when the site is affected by a landslide; $P_{(T:S)}$. **(37)**

**Tip**:

**a)** Accumulation at the toe/foot of the main body. **(3)**

**b)** Point of the toe farthest from the top of a landslide (see Fig. 1). **(17, 35)**

**c)** Point on the toe most distant from the top of the slide. **(34)**

**Toe**:

**a)** Lower usually curved margin of the displaced material of a landslide, it is the most distant from the main scarp**. (3)**

**b)** Downslope portion of a landslide. **(4)**

**c)** Lower, usually curved, margin of the disturbed material of a landslide that has often overridden undisturbed terrain. **(14)**

**d)** Lower, usually curved, margin of the displaced material of a landslide, the most distant from the top of a landslide (see Fig. 1). **(19, 38)**

**e)** Margin of displaced material most distant from the main scarp. **(34)**

**f)** Farthest and lowermost curved surface of displaced landslide materials pushed over on to the undisturbed slope; the downslope end of an alluvial fan. **(35)**

**Toe of Surface of Rupture**: Intersection (usually buried) between the lower part of the surface of rupture of a landslide and the original ground surface (see Fig. 1). **(34, 38)**

**Tolerable Risk**:

**a)** Risk within a range within which society can live in order to have and secure certain benefits; a range of risk regarded as non-negligible but needing to be kept under review and reduced further if possible. **(13, 66)**

**b)** Risk that stakeholders are willing to live with so as to secure certain net benefits, knowing that the risk is being properly controlled, kept under review, and further reduced as and when possible. **(40)**

**c)** Risk within a range that society can live with so as to secure certain net benefits; a range of risk regarded as non-negligible and needing to be kept under review and reduced further if possible; this can also be thought of as risk appetite; defined as the amount and type of risk that society is prepared to pursue, retain or take. **(68)**

**Top**: Highest point of contact between the displaced material and the main scarp of a landslide (see Fig. 1). **(34, 38)**

**Topple**:

**a)** This is characterised by the tilting of rock without collapse, or by the forward rotation of rocks about a pivot point. Topples have a rapid rate of movement and failure is generally influenced by the fracture pattern in rock. Material descends by abrupt falling, sliding, bouncing and rolling. **(2)**

**b)** Forward rotation out of slope of soil or rock about a point or axis below the centre of gravity of the displaced mass. Extremely slow to extremely rapid sometimes accelerating throughout the movement. **(3)**

**c)** Similar to a fall except that it involves the forward rotation, out of the slope, of a mass of soil and/or rock about a point or axis below the centre of gravity of the displaced mass. **(9)**

**d)** Large rock mass that has fallen over. **(12)**

**e)** Type of landslide movement that involves the forward rotation of a mass of soil or rock about a central point below the displaced mass. **(14)**

**f)** Slope failure that involves vertically downward motion under gravity of a block without internal deformation, but with rotation. **(22)**

**g)** Slope movement that occurs due to forces that cause an over-turning moment about a pivot point below the centre of gravity of the slope. A topple is very similar to a fall in many aspects, but do not involve a complete separation at the base failure. **(29)**

**h)** Block of rock that tilts or rotates forward, eventually to fall, bounce, or roll down the slope as a rockfall. Often also used for the whole event, including the rockfall deposit. **(34)**

**i)** Block of rock that tilts or rotates forward to fall, bounce, or roll down the slope. **(35, 57)**

**j)** Forward rotation, out of the slope of a mass of soil or rock, about a point or axis below the centre of gravity of the displaced mass. **(38)**

**k)** Involve the outward rotation (or inward buckling and basal collapse) of angular blocks or rock columns that become detached from cliffs. **(42)**

**l)** Involve the forward rotation of rock or sediment about a pivot under the influence of gravity. Movement occurs along steeply inclined fractures. Topples range from shallow movements to deep-seated displacements of large volumes of rock. **(43)**

**m)** Have been recognized relatively recently as a distinct type of movement. This kind of movement consists of the forward rotation of a unit or units about some pivot point, below or low in the unit, under the action of gravity and forces exerted by adjacent units or by fluids in cracks. **(54)**

**n)** Consist of rapid rotation of a unit of rock or soil about some pivot point. Toppling may not lead to falls, slides or flows. **(56)**

**o)** Forward rotation out of the slope of soil and rock on an axis below the centre of gravity of the displaced material. Toppling is sometimes caused by the movement of material upslope of the displaced material and sometimes by water or ice in cracks. Topples can lead to falls or slides of the displaced material. Topples range from extremely slow to extremely rapid…..sometimes accelerating throughout the movement. **(63)**

**Total Length (L)**: Minimum distance from the tip of a landslide to its crown (see Fig. 2). **(19, 38)**

**Total Risk**: see Risk (3)

**a)** Risk to all specific elements from all specific hazardous affecting landslides. **(40)**

**b)** Consists of the number of lives likely to be lost, the persons injured, damage to property and disruption to activities caused by a particular natural phenomenon. It is the product of the specific risk (Rs) and the elements at risk (E): Rt= (E)(Rs)=(E)(H.V). **(42)**

**c)** Means the expected number of lives lost, persons injured, damage to property, or disruption of economic activity due to a particular natural phenomenon, and is therefore the product of specific risk ($R_s$) and elements at risk (E). Thus: $R_t = (E)(R_s) = (E)(HxV)$. **(55, 60)**

**d)** Sum of the specific risks, or the sum of the product of the annual probability of occurrence, the elements at risk and the vulnerability ($R = P_a \times E \times V$). **(56)**

**Translational**:

**a)** Slides have a planar, or two dimensional surface of rupture. **(2)**

**b)** Mass in a translational landslide moves out, or down and outward, along a relatively planar surface with little rotational movement or backward tilting. This type of slide may progress over considerable distances if the surface of rupture is sufficiently inclined, in contrast to rotational slides, which tend to restore the slide equilibrium. The material in the slide may range from loose, unconsolidated soils to extensive slabs of rock, or both. Translational slides commonly fail along geologic discontinuities such as faults, joints, bedding surfaces, or the contact between rock and soil. In northern environments the slide may also move along the permafrost layer**. (3)**

**c)** Landslide that moves approximately parallel to the slope of the ground. **(22)**

**d)** Landslide in which the mass of soil and rock moves out or down and outward with little rotational movement or backward tilting. Material from a translational landslide may range from loose unconsolidated soils to extensive slabs of rock and may progress over great distances if conditions are right. **(34, 35)**

**e)** Type of landslide that moves along a roughly planar surface with little rotation or backward tilting. **(38)**

**f)** Relatively flat, planar movements along surfaces are called translational slides. These are common where the bedding planes of sedimentary or metamorphic rocks dip in the direction of slope and blocks detach and slide along them. **(42)**

**g)** Sliding takes place on planar or undulating surfaces dipping in the direction of the slope. **(43)**

**h)** Mass progresses out or down and out along a more or less planar or gently undulatory surface and have little of the rotary movement or backward tilting characteristics of slump. **(54)**

**i)** Translational slides are by far the most common form of landslide occurring in soils. They are always shallow features and have essentially straight slide planes which usually develop along a boundary between soil materials of different density or permeability. **(55)**

**j)** Slides involve the movement of many rock or soil units along a plane. If few distinct units are involved, the movement is referred to as “translational block slide”. Often the failure plane existed before movement occurred. **(56)**

**k)** Mass of soil and rock moves out or down and outward with little rotational movement or backward tilting. Translational landslides material may range from loose, unconsolidated soils to extensive slabs of rock and may progress over great distances under certain conditions. **(57)**

**Travel Angle:** Considered synonymous by some to the angle of reach or fahrböschung. It is the slope of a line connecting the highest point on the main scarp of the landslide to the distal end of the displace material. **(63)**

**Trigger**:

**a)** Possible triggers: rainfall, earthquakes, snow melting. **(3)**

**b)** Cause that puts a slope into a marginal state of activity leading to a landslide. **(38)**

**Upslope**:

**a)** Area of a location that is experiencing ground movement. It is the highest point of the effected slope, typically indicated by principle and secondary scarps, followed by a zone of depression slightly further down the slope. **(38)**

**b)** Slope that lies upward or uphill. **(6)**

**Velocity**: Rate of movement of a landslide that can range from extremely slow (<16 mm/year or $0.5\times10^{-6}$ mm/second) to extremely rapid (>5 m/second). **(38)**

**Very Wet**: Material that contains enough water, to flow as a liquid under low gradients. **(38, 63)**

**Voluntary Risk**: Risk that an individual or society typically takes willingly. **(40)**

**Vulnerability**:

**a)** Propensity or predisposition to be adversely affected. **(1)**

**b)** Vulnerability is the degree of fragility of a (natural or socioeconomic) community or a (natural or socio-economic) system towards natural hazards. Vulnerability is determined by the typology of a natural hazard, the resulting risk and the potential to react to and/or to withstand it, i.e. its adaptability, adaptive capacity and/or coping capacity. **(8)**

**c)** Characteristic of human behaviour, social, and physical environments, describing the degree of susceptibility (or resistance) to the impact of e.g. natural hazards. Vulnerability is

determined by combining hazard awareness, condition of human settlements and infrastructure, public policy and administration, and organizational strength in disaster management. Poverty is one of the main causes of vulnerability in many parts of the world. **(8)**

**d)** (system) Characteristic of a system that describes its potential to be harmed. This can be defined as the product of susceptibility and value. **(8)**

**e)** Susceptibility of human settlements to the harmful impacts of natural hazard. **(8)**

**f)** Characteristics of a person or group and their situation that influence their capacity to anticipate, cope with, resist and recover from the impact of a natural hazard. **(8)**

**g)** Condition wherein human settlements or buildings are threatened by virtue of their proximity to a hazard, the quality of their construction, or both. Degree of loss (from 0 percent to 100 percent) resulting from a potential damaging phenomenon. **(8)**

**h)** Degree of loss (from 0% to 100%) resulting from a potential damaging phenomenon. **(9)**

**i)** Level of exposure of human life, property, and resources to damage from natural hazards. (**5**)

**j)** Measure of the robustness (or alternatively, the fragility) of an element at risk, and its exposure to (or alternatively, protection from) a landslide; or probability or degree of potential loss to a given element at risk or a set of elements at risk within an area affected by a landslide; $V_{(L:T)}$ expressed on a scale of 0 (impossible or no loss) to 1 (total loss). **(13)**

**k)** Set of conditions and processes resulting from physical, social, economic, and environmental factors, which increase the susceptibility of a community to the impact of hazards. **(10)**

**l)** Degree to which a person, community, or system is adversely affected by a hazard. Vulnerability is the combined product of exposure and sensitivity**. (22)**

**m)** Characteristics and circumstances of a community, system or asset that make it susceptible to the damaging effects of a hazard. **(24)**

**n)** Degree to which a system is susceptible to, and unable to cope with, adverse effects of climate change, including climate variability and extremes. Vulnerability is a function of the character, magnitude, and rate of climate change and variation which a system is exposed, its sensitivity and its adaptive capacity. **(26)**

**o)** Conditions determined by physical, social, economic and environmental factors or processes, which increase the susceptibility of a community to the impact of hazards**. (26)**

**p)** Vulnerability describes the degree of loss or damage to a particular element of the infrastructure or community (e.g. buildings, underground services, economic activity). **(31)**

**q)** Exposure to damage. **(34)**

**r)** Degree of loss to a given element at risk or set of such elements resulting from the occurrence of a natural phenomenon (or manmade) of a given magnitude and expressed on a scale from 0 (no damage) to 1 (total loss). **(39, 32)**

**s)** Potential for harm or loss. **(43)**

**t)** Susceptibility of an element to a hazardous event and is commonly thought of as having technological and human dimensions**. (45)**

**u)** Refers to the propensity to suffer some degree of loss (e.g., injury, death, and damages) from a hazardous event. **(49)**

**v)** Means the degree of loss to a given element or set of elements at risk resulting from the occurrence of a natural phenomenon of a given magnitude. **(55)**

**w)** Degree of damage caused by a landslide hazard to the elements at risk. It is usually expressed in relative terms, using words such as "no damage", "some damage", "major damage", "and total loss", or by a numerical scale between 0 (no damage) and 1 (total loss). **(56)**

**x)** Degree of loss to a given element or set of elements at risk resulting from the occurrence of a natural phenomenon of a given magnitude. It is expressed on a scale from 0 (no damage) to 1 (total loss). **(60)**

**Wet**: Material that contains enough water to behave in part as a liquid, has water flowing from it, or supports significant bodies of standing water. **(38, 63)**

**Widening**:

**a)** Rupture surface is expanding at one or both lateral margins of the landslide. **(33)**

**b)** Activity where the rupture surface extends into one or both flanks of a landslide. **(38)**

**Width of the Displaced Mass ($W_d$)**: Maximum breadth of the displaced mass perpendicular to the length ($L_d$) (see Fig. 2). **(19, 38)**

**Width of the Rupture Surface ($W_r$)**: Maximum width between the flanks of a landslide, perpendicular to the length ($L_r$) (see Fig. 2). **(19, 38)**

**Zone of Accumulation**: Portion of a landslide within which the displaced material lies above the original ground surface (see Fig. 1). **(19, 34, 38)**

**Zone of Depletion**: Portion of a landslide within which the displaced material lies below the original ground surface (see Fig. 1). **(19, 34, 38)**

**Zoning**:

**a)** Local governments' tool that regulates land-use, promotes orderly growth, and protects existing property owners by ensuring a convenient, attractive and functional community. Zoning is the way the local governments control the physical development of land and the kinds of uses to which each individual property may be put. **(8)**

**b)** Territory relative to each natural hazard and risk is a subdivision of the territory in areas, which could be affected by hazardous phenomena to variable degrees. **(8)**

**c)** Division of land into somewhat homogeneous areas or domains, and their ranking according to degrees of actual or potential landslide susceptibility, hazard or risk or applicability of certain landslide-related regulations. **(13)**

**d)** Division of the land surface into areas and the ranking of these areas according to degrees of actual or potential hazard from landslides or other mass movements on slopes. **(35)**

**e)** Natural hazard zoning is the division of any determined space into areas which could be affected by hazardous phenomena to variable degrees. **(43)**

**f)** Term "zonation" applies in a general sense to division of the land surface into areas and the ranking of these areas according to degrees of actual or potential hazard from landslides or other mass movements on slopes. **(60)**

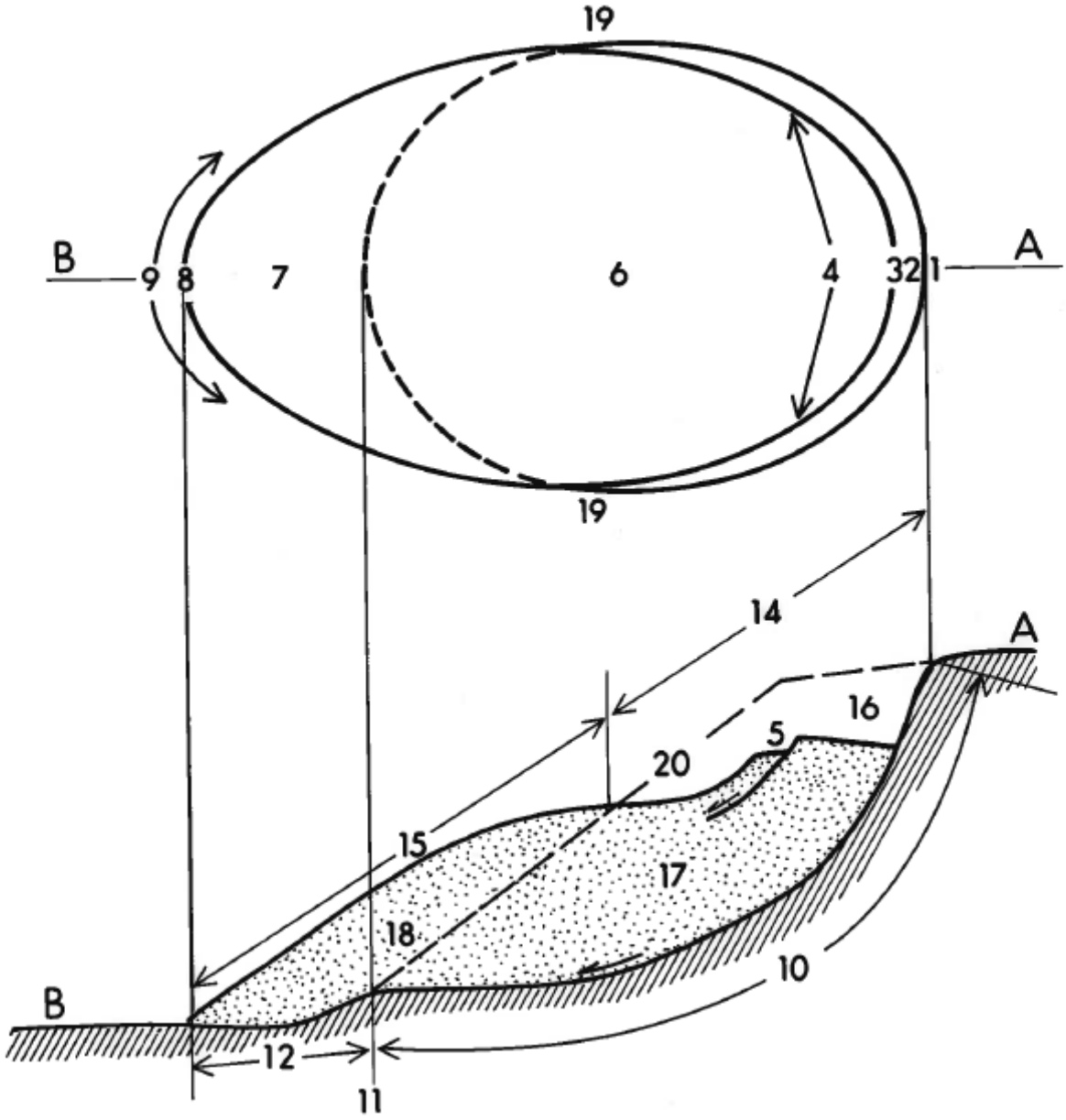


Figure 1. Landslide features (Cruden and Varnes, 1996). 1. Crown. 2. Main scarp. 3. Top. 4. Head. 5. Minor scarp. 6. Main body. 7. Foot. 8. Tip. 9. Toe. 10. Surface of rupture. 11. Toe of surface of rupture. 12. Surface of separation. 13. Displaced material. 14. Zone of depletion. 15. Zone of accumulation. 16. Depletion. 17. Depleted mass. 18. Accumulation. 19. Flank. 20. Original ground surface. See above pages for definitions of features.

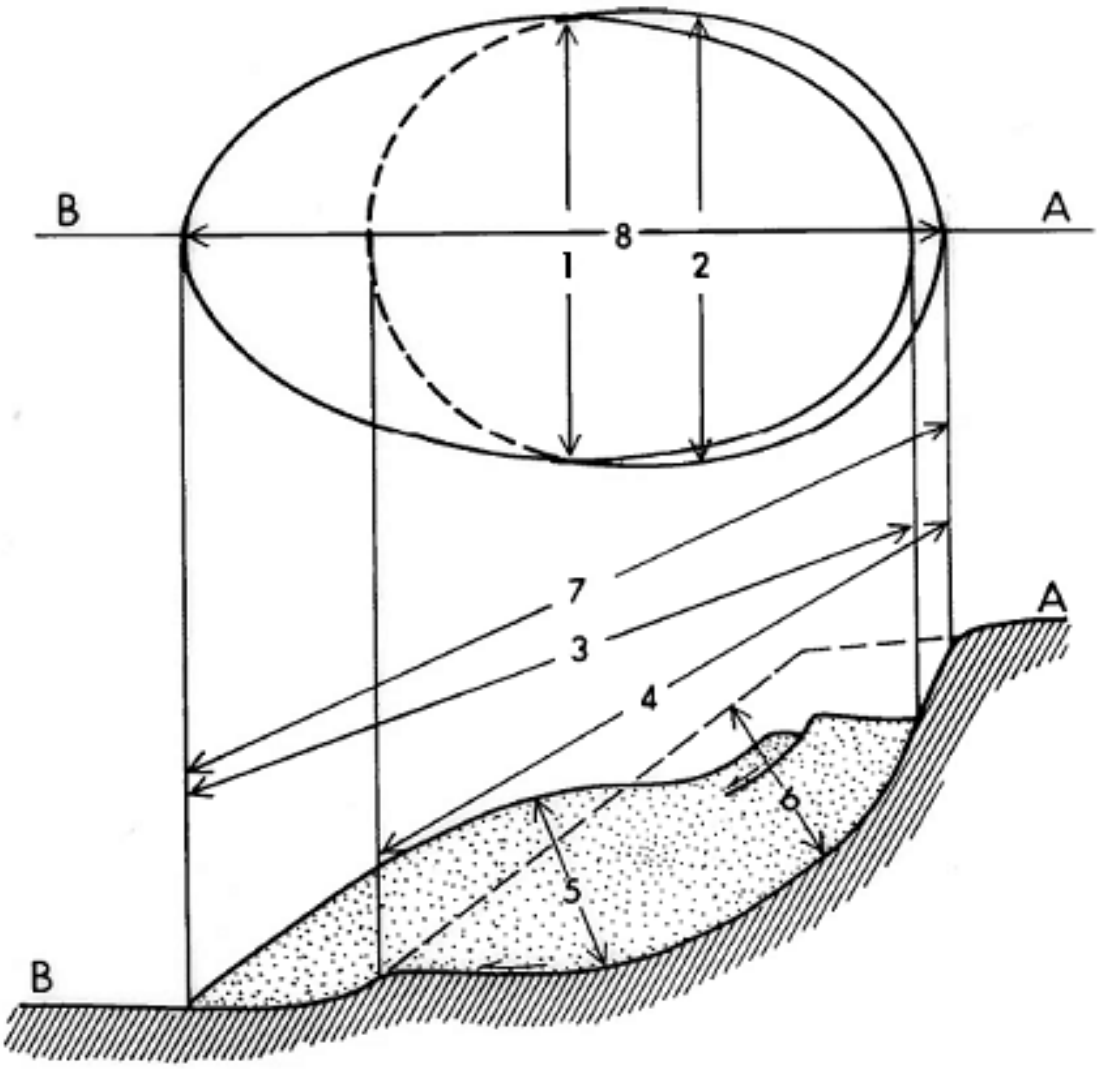


Figure 2. Landslide dimensions (Cruden and Varnes, 1996). 1. Width of displaced mass, $W_d$. 2. Width of surface of rupture, $W_r$. 3. Length of displaced mass, $L_d$. 4. Length of surface of rupture, $L_r$. 5. Depth of displaced mass, $D_d$. 6. Depth of surface of rupture, $D_r$. 7. Total length, L. 8. Length of centre line, $L_{cl}$. See above pages for definitions of landslide dimensions.

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