Preface

The term “landslide” describes a wide variety of processes that result in the downward and outward movement of slope-forming materials including rock, debris, soil, artificial fill, or a combination of these.

This includes a wide variety of phenomena, from simple fall of rock blocks from vertical faces, through topples, to landslides that are dominated by sliding motion and those dominated by flows of soil and/or rock. Landslides are strongly correlated with other types of natural hazards, such as floods, droughts, wildfires, earthquakes, tsunamis, and volcanoes, and are often involved in cascading events of multi-hazard disasters.

Climate change, increased susceptibility of surface soil to instability, anthropogenic activities, growing urbanisation, uncontrolled land-use and increased vulnerability of population and infrastructure, contribute to the growing landslide risk. In the Thematic Strategy for Soil Protection (COM232/2006), landslides are considered one of the main threats to European soils. The societal and economic impact of landslide risk is difficult to be assessed and it is underestimated since a relevant part of related damage is attributed to other natural hazards, in multi-hazard chains (i.e. seismically induced failures, rainfall induced debris flows, lahars and rock avalanches associated to volcanism).

The various types of landslides can be differentiated by the kinds of material involved and the mode of movement. Five main different types of movements have been discerned (Cruden and Varnes 1996, Hungr et al. 2014), which are: falls, topples, slides, spreads, or flows.

Landslides are classified also according to the type of material involved. According to Cruden and Varnes (1996) material can be rock or soil; the latter is described as earth if mainly composed of sand-sized or finer particles and debris if composed of coarser fragments. Hungr et al., (2014) proposed a new classification of material in order to provide compatibility with accepted geotechnical and geological terminology of rocks and soils.

The proposed list of material types is: “rock,” “clay,” “mud,” “silt,” “sand,” “gravel,” “boulders,” “debris,” “peat,” and “ice”.

Landslides are thus described using two terms that refer respectively to material and movement.

Landslides vary greatly in size. At the largest scale, a single landslide can involve up to some cubic kilometer of rock and soils. At the other end of the scale, a small boulder has the potential to cause loss of life if it strikes an individual, or to cause mass fatalities if it, for example, induces a train to derail. In general, the potential to cause loss scales with size of the landslide, largely because of the scaling of the kinetic energy and the affected area.

Landslide can be distinguished also on the basis of the rate of movement and according to Cruden and Varnes (1996) seven classes of velocity can be identified, from extremely slow to extremely rapid. Velocity is an important parameter, strongly related to the degree of damage to the elements at risks.

Landslide occurrence varies according to different causes such as topographic profile, geology, tectonic history, weathering and erosional history, and land use.

However, landslides are usually considered to have only one trigger (Varnes 1978). A trigger is an external stimulus such as an intense rainfall event, an earthquake, a volcanic

eruption, a storm wave, or rapid stream erosion that causes a near-immediate response in the form of a landslide by rapidly increasing the stresses or strains and reducing the strength of the slope-forming materials (Wieczorek 1996). Rainfall is one of the most important triggering factor of landslides. The type of landslide produced in this case depends largely upon the frequency and magnitude, in terms of intensity and/or duration, of the rainfall events (Fukuoka 1980, Wieczorek 1987). Both shallow and deep-seated landslides can be triggered by rainfall, with different frequencies, both in time and space, and under the effects of different types of storms.

Earthquakes can trigger different types of landslides in different geological, topographic and climatic conditions and the dimension of landslides can vary from small rock falls to giant landslides. Earthquakes in steep landslide-prone areas largely increase the likelihood that landslides will occur, due to the ground shaking alone, liquefaction of susceptible sediments, or shaking-caused dilation of soil materials, which allows rapid infiltration of water. Ground shaking can also cause rock falls or rock topples due to loosening of rocks.

Landslides and other types of natural hazards such as floods, droughts, wildfires, tsunamis, and volcanoes can be strongly correlated to the so-called cascade effects. For example, landslides can cause flooding by forming landslide dams that block valleys and stream channels, allowing large amounts of water to back up. On the contrary, droughts and fires can produce bare soils (or lands with reduced vegetal protection) exposed to the direct consequences of rainfalls and weathering phenomena.

This volume of WLF4 includes recent research achievements related to different landslide types in terms of typology, material and triggering factors. This volume will include also research outcomes made on the relationship between landslides and other natural hazards.

In particular, this volume has been organized in five chapters that correspond to the following sessions:

Session 4.1 – Earthquake-induced landslides;

Session 4.2 – Rainfall-induced landslides;

Session 4.3 – Rapid landslides: debris flows, mudflows, rapid debris-slides;

Session 4.4 – Landslides in rocks and complex landslides: rock topples, rock falls, rock slides, complex landslides;

Session 4.5 – Landslides and other natural hazards: floods, droughts, wildfires, tsunamis, and volcanoes.

Florence, Italy Nicola Casagli

References

Cruden DM, Varnes DJ (1996) Landslide types and processes. In: Turner AK, Schuster RL (ed) Landslides investigation and mitigation, Special Report 247, National Academy Press, Washington, DC

Fukuoka M (1980) Landslides associated with rainfall. Geotech Eng 11:1–29

Hungr O, Lerouei S, Picarelli L (2014) The Varnes classification of landslide types, an update. 11(2), pp 167–194.

Varnes DJ (1978) Slope Movement Types and Processes. In: Schuster RL, Krizek RJ (ed) Landslides: analysis and control, special report 176, TRB, National research Council, Washington, DC

Wieczorek GF (1987) Effect of rainfall intensity and duration on debris flows in central Santa Cruz Mountains, California. Geol Soc Am. Rev EngGeol 7:93–104

Wieczorek GF (1996) Landslide triggering mechanisms. In: Turner, Shuster (eds) Landslides: investigation and mitigation. Transportation Research Board-National Research Council, Special Report, vol 247, pp 76–90

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