



Landslides in Higher Education Curricula and Beyond

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Abstract

Education is a human right and plays a decisive role in capacity building from the pre-school level to professional, under-, and postgraduate university study programmes in higher education institutions and beyond, such as summer schools or as a part of lifelong education for a general audience. It gives us a profession or helps the general population and diverse stakeholders (e.g., policy and decision makers) increase society's resilience against natural hazards, such as landslides. Thus, education finds a principal place also in numerous international documents accepted by the UN organizations.

The article looks at education as a topic of international strategic documents on disaster risk reduction. It uses diverse web tools and databases to assess worldwide efforts in teaching/education on landslides and their disaster risk reduction at higher education levels and beyond. The focus is on the higher education study programmes offering courses on slope stability and landslide mitigation. This topic is widely covered by study programmes in the field of disaster risk management and classical study programmes in civil, geological, geotechnical engineering, as well as in geology and geography. The second cycle covers the landslide topic, i. e. master study programmes and university programmes are prevailing. There is an apparent lack of academic programmes offered as blended programmes or distance learning programmes in disaster risk reduction, including landslide risk. Certificates and diploma levels prevail among academic programmes offered as online courses or continuing education.

The web search found a few (summer) schools dedicated to landslide topics and a variety of other open-access material that can be used for education and capacity

building, such as blogs, databases, teaching tools, presentations, or video lectures.

The International Consortium on Landslides might offer collected information in this article on its web pages under the topic "Educational tools" and then open it up to their members and landslide community to contribute to the content by sending links to elsewhere freely available educational material in landslide disaster risk reduction.

Keywords

Disaster Risk Reduction · Higher education · Landslides · MOOCs · Summer schools · Sustainable Development Goals · University curricula

1 Introduction

1.1 General Views on Higher Education

Article 26 of the United Nations Universal Declaration of Human Rights (UDHR) states "Everyone has the right to education. Education shall be free, at least in the elementary and fundamental stages. Elementary education shall be compulsory. Technical and professional education shall be made generally available and higher education shall be equally accessible to all on the basis of merit." (UN 1948).

The Sendai Framework for Disaster Risk Reduction 2015–2030 (UNDRR Preventionweb 2015) supports education as one of the strategic tools for its implementation. The term "culture of prevention and education" is used.

For the SFW "Priority 1: Understanding disaster risk", at the national and local levels, it is important to (UNDRR Preventionweb 2015; 24(g); 24(l)):

- To build the knowledge of government officials at all levels, civil society, communities and volunteers, as well as the private sector, through sharing experiences, lessons

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learned, good practices and training and education on disaster risk reduction, including the use of existing training and education mechanisms and peer learning;

- To promote the incorporation of disaster risk knowledge, including disaster prevention, mitigation, preparedness, response, recovery, and rehabilitation, in formal and non-formal education, as well as in civic education at all levels, as well as in professional education and training;

Understandably, landslides are not mentioned in these documents separately from other disasters and are covered under the more general topic of disaster risk reduction.

The Global Alliance for Disaster Risk Reduction & Resilience in the Education Sector (GADRRRES) is a multi-stakeholder platform comprised of UN Agencies, International Non-Governmental Agencies, other leading humanitarian and development organizations, and similar regional alliances, advocating for and supporting child rights, resilience, and sustainability in the education sector. In 2022, the “Comprehensive School Safety Framework 2022–2030—for Child Rights and Resilience in the Education Sector” was published (GADRRRES 2022). The framework provides a comprehensive approach to resilience and safety from all hazards (including landslide/rockslide, debris or mud-flow and glacial lake outbursts) and all risks confronting education and child protection sector populations, systems, and programs. It supports access, quality, and management strategies in the education sector.

Recently, UNESCO published a new social contract under the motto “Futures for Education”—a global initiative to reimagine how knowledge and learning can shape the future of humanity and the planet (UNESCO 2021). The report stresses the need for quality education throughout life (lifelong learning) and asks universities and other higher education institutions to be active in every aspect of building a new social contract for education. The topic of landslides, landslide research and technology, and landslide disaster risk reduction is clearly an education topic that must incorporate reinvented higher education goals, such as inter and intra-disciplinarity, lifelong learning approach, or programme diversity and flexible learning pathways (UNESCO 2022a).

Education is also strongly integrated into the IHP-IX Strategic Plan of the Intergovernmental Hydrological Programme (UNESCO IHP) entitled “Science for a Water Secure World in a Changing Environment” (UNESCO 2022b). This Ninth Phase of the UNESCO IHP is running in the period 2022–2029, sets one of five Performance Indicators (PI) as PI 2: The number of Member States with enhanced water informal, formal, and non-formal education at all levels, and as one five Priority Areas (PA) as PA 2: Water education in the Fourth Industrial Revolution including Sustainability (UNESCO 2022b). This document lists

among the challenges and opportunities also water security as the capacity of a population to ensure efficient protection of life and property against water-related hazards such as floods, landslides, land subsidence, and droughts.

The International Consortium on Landslides (ICL) accepted the Final Draft of the Kyoto 2020 Commitment for Global Promotion of Understanding and Reducing Landslide Disaster Risk which was signed by the first signatories in September 2019 (Sassa 2019). This commitment supports the implementation, follow-up, and review of the Sendai Framework 2015–2030, the UN 2030 Agenda for Sustainable Development, the New Urban Agenda, and the Paris Climate Agreement as it addresses the adverse effects of climate change.

The text of KLC2020 is available on the ICL web (ICL 2023b). Among the accepted 10 priority actions, Action 5 deals with: “The promotion of open communication with local governments and society through integrated research, capacity building, knowledge transfer, awareness-raising, training, and educational activities, to enable societies and local communities to develop effective policies and strategies for reducing landslide disaster risk, to strengthen their capacities for preventing hazards from developing into major disasters, and to enhance the effectiveness and efficiency of relief programs.” (ICL 2023b).

1.2 The Focus of this Article

The research questions in this article were: (i) assess the importance of higher education on specific landslides in selected international strategic documents on disaster risk reduction, and (ii) assess the worldwide efforts in teaching/educating on landslides and their disaster risk reduction in higher education curricula and beyond—in a more open education forms that are also offered by the International Consortium on Landslides.

2 Materials and Methods

The United Nations Office for Disaster Risk Reduction (UNDRR) Prevention web pages offer among other educational resources also, a list of academic programmes in disaster risk reduction (UNDRR 2022a, b). The platform offers 300+ academic programmes in the field of disaster risk management, at the following levels: bachelor, master’s, certificate/diploma, and doctorate, and of the following types: blended programme, continuing education, distance learning, online courses, and academic programmes.

When searching for master studies around the world, web pages of the FindAUniversity, Sheffield, UK, and their search platform “FindAMaster”, launched in 2004, were used

(FindAUniversity 2023). The platform is a directory of nearly 25,000 master's degrees and postgraduate qualifications at universities around the world—it includes Master's degree programmes, including part-time, distance learning, Master of Arts (MA), Master of Science (MSc), MBA (Master of Business Administration), Master of Research (MRes), and Master by Research (MPhil) programmes as well as other postgraduate study opportunities.

Another tool applied was the Studyportal (2023), offering 200,000+ courses at 3750+ educational institutes across 110 countries. The offered portals for each of the three Bologna cycle study programs: Bachelor degrees (www.bachelorsportal.com, 105,000+ Bachelors), Master degrees (www.mastersportal.com, 85,000+ Masters), and Ph.D. degrees (www.phdportal.com, 6000+ PhDs). Study programmes at each portal can be searched in 18 fields, such as Engineering & Technology, or Natural Sciences & Mathematics.

Furthermore, Google Search was performed using keywords: university, higher education, landslides, disaster risk control, certificate, certified.

Finally, we search the Web of Science (Clarivate Analytics 2023) using the keywords “summer school” AND “landslide”. Also, the web portal for summer schools in Europe (www.summerschoolsineruoep.eu) was tried to find landslide disaster risk reduction events.

3 Results and Discussion

3.1 Background Studies on Landslides and Study Programmes

Searching the SCOPUS and Web of Science databases for published studies on study programmes or courses regarding slope stability or landslides (mass movements, debris flows) revealed only a few published studies on this topic.

Bæverfjord and Thakur (2008) reported on two quick clay slides in Norway, and how these two case studies have impacted the teaching at the Norwegian University of Technology and Science (NTNU), Trondheim, Norway, provided by the Geotechnical Group at NTNU—mainly in the form of the International Master programme in Geotechnics and Geohazards.

Ozkazanc and Yuksel (2015) acknowledged the need for disaster mitigation education by determining the level of disaster awareness of students of Gazi University Faculty of Architecture, City and Regional Planning in Turkey.

Munoz et al. (2020) analyzed school safety and disaster education in South America (Brazil, Colombia) and the Caribbean (Cuba, the Dominican Republic, Jamaica, and Puerto Rico) in order to increase understanding of natural hazards and disaster preparedness.

Lo Presti (2013) reported on the intrinsic advantages and possible drawbacks of an inductive teaching approach at the University of Pisa (Italy) in the master course in Civil Engineering of Infrastructures, teaching a class on “slope stability” on the basis of a real case study. A later study reported on three-year experiences with this teaching approach (Giusti and Lo Presti 2015). Dewi (2020) on the other hand, stresses that combining fieldwork and research was possible to gain geography students' understanding of disaster risk reduction in the school community especially in disaster-prone areas such as Central Java, Indonesia. Ranglund et al. (2018) report on student gaming and active scenario building using different platforms during a Bachelor in Crisis Management and Communication course at The Inland Norway University of Applied Sciences. A virtual town was programmed in which different bad things happen, among them landslides. The students' reactions were very positive. These studies stress the importance of studying landslide disaster risk reduction in real cases, and it would be of great importance to have detailed databases on such landslide cases around the world so that educators can select appropriate cases and use them in the curriculum.

The need to incorporate natural hazards mitigation and strategies into engineering study programmes was not studied much in periodicals; two studies deal with civil engineering curriculum (Perdomo and Pando 2014; Cross and Kaklamanos 2017). Another recently published study looked at physics education students at Tadulako University in Indonesia, and their understanding on the environmental concept of landsliding (Hatibe et al. 2020). Similarly, a study by Labibah et al. (2020) aimed to find out the role of integrated landslide disaster education in physics subject viewed from high school student's preparedness in Kulon Progo, Yogyakarta in Indonesia, and concluded that it is very crucial to be implemented in learning and teaching activities using integrated learning model to raise disaster preparedness and students' science knowledge.

Guo et al. (2020) realized that landslide hazard education to the public could enhance their awareness of disaster risk. Since current disaster education is mainly aimed at students and ambulance personnel, where education methods focus on textbook teaching and professional training, there is a lack of effective communication channels between educators and the public. Hence, they proposed a visual representation method of landslide hazards, focusing on the combination of dynamic and static visual representation frameworks. This study stresses the potential of technologies such as augmented reality and visualization techniques in disaster risk dialogue and teaching natural hazards.

Sezgin and Cirak (2021) studied the role of Massive Open Online Courses (MOOC) in engineering education using an exploratory systematic review of peer-reviewed literature. Their study's findings indicate that online virtual labs, social

networks, flipped classroom strategy, active learning, small private online courses, and motivation are the key lodestar topics in “MOOCs in engineering education research” and engineering education researchers mostly employ practice-based and quantitative research approaches. Looking at Web of Science and using the search “MOOC AND disaster” in Topic (title, abstract, author keywords, Keywords Plus), yielded only 3 results, using the search “MOOC AND landslide*” yielded no hits whatsoever.

3.2 Academic Programmes in Disaster Risk Management

Using the PreventionWeb platform, over 300+ academic programmes were retrieved from the database—the details on the level and type of these programmes are given in Table 1.

Most academic programmes in disaster risk management are university programmes, among online courses certificates and diploma, are the most frequent levels; the same is true for continuing education. Not many academic programmes are offered as Ph.D. (Doctor of Philosophy), i.e., doctoral studies in disaster risk reduction. There is still much free room for distance learning courses and online courses of disaster risk reduction; this is also true for landslide disaster risk reduction.

3.3 University Study Programs in Disaster Risk Reduction & Management

Using FindAMaster platform, in total 35 master’s degrees were found as of February 2023 in disaster risk reduction. The offered degrees are from Master of Science (MSc), Master of Arts (MA), and Master of Research (MRes), over Postgraduate Certificates (PG Cert) to Postgraduate Diploma (PG Dip). The search results are presented in Table 2. Using the same platform again, 14 master’s degrees and 1 Ph.D. degree were found as of February 2023 in the field of landslide(s). The search results are presented in Table 3.

Using the Studyportals (2023) and searching for master’s degrees, within the discipline “Applied Sciences & Professions” and in the field of “Emergency & Disaster Management”, there are 202 master’s degrees—131 degrees were offered as on-campus learning, 89 degrees as on-line learning, and 10 as blended learning (several options for each degree were possible). Out of 202 degrees, 93 are offered in North America, 63 in Europe, 24 in Oceania, 19 in Asia, only 3 in Africa, and none in South America. In Table 4, selected master’s degrees out of 202 degrees listed in the Master portal are presented with links to the study programmes description. Comparably, using the Bachelor portal and the PhD portal, for the field of “Emergency & Disaster Management”, there are 148 bachelor’s degrees offered (110 in the North America, and 30 in Europe, and a few elsewhere), and only 3 PhD degrees.

Using the Google search for academic programmes, some results are presented in Table 5. Among other institutions, the University of Geneva offers a Specialization Certificate for the Assessment and Management of Geological and Climate Related Risk with a stand-alone Landslide Risk module (UG 2023). This module addresses landslide risk assessment: description and characterization and mechanisms of slope movements, such as landslide, rock instabilities, and debris flows are discussed; an overview of hazard, risk assessment and mapping are provided, including empirical and modeling approaches; finally protective measures are discussed. University of Twente offers a Master of Science programme in Geo-information Science and Earth Observation with eight specializations, including Natural Hazards and Disaster Risk Reduction (UT 2023).

The Massive Open Online Courses (MOCCs), invented in 2008 as a distance education tool, were widely introduced into education and distance learning in 2012. They are online teaching form reaching large numbers of students and are to be distinguished from traditional face-to-face classroom teaching. MOCCs that were found on the web using Google search and are related/covering topics on slope stability and landslides are presented in Table 6. Quite some courses are available for free of different levels (no prior knowledge necessary), can be absolved after enrolling before flexible

Table 1 Academic programmes found as of early February 2023 in the PreventionWeb platform in disaster risk reduction (UNDRR 2022b)

Academic programme type	Academic programme level			
	Bachelor	Certificate/Diploma	Masters	Doctorate
Blended programmes	1	3	7	0
Continuing education	1	15	1	0
Distance learning	3	7	2	0
Online courses	1	19	8	0
University programmes	36	58	115	24

Table 2 The selected master's degrees in disaster risk reduction as of early February 2023, using the FindAMaster platform (www.findamasters.com), sorted by the institution name

University	Title of the program	Source
Bournemouth university	MSc—Disaster management	https://www.findamasters.com/masters-degrees/course/msc-disaster-management/?i21d4134c50143
Coventry University	MSc—Disaster management and resilience	https://www.findamasters.com/masters-degrees/course/disaster-management-and-resilience-msc/?i49d2694c2601
	PGCert—Disaster, risk and resilience	https://www.findamasters.com/masters-degrees/course/disaster-risk-and-resilience-pgcert/?i49d2694c65862
Durham University	MA—Climate, risk & society	https://www.findamasters.com/masters-degrees/course/ma-climate-risk-and-society/?i67d5259c17271
	MA—Environmental Hazards & Risk	https://www.findamasters.com/masters-degrees/course/ma-environmental-hazards-and-risk/?i67d5259c69422
	MSc—Climate, risk & society	https://www.findamasters.com/masters-degrees/course/msc-climate-risk-and-society/?i67d5259c69421
	MSc—Environmental Hazards & Risk	https://www.findamasters.com/masters-degrees/course/msc-environmental-hazards-and-risk/?i67d5259c69423
Loughborough University	MSc—Flood modelling and management	https://www.findamasters.com/masters-degrees/course/msc-flood-modelling-and-management/?i153d6593c66891
Northumbria University, Newcastle	MSc—Disaster management and sustainable development	https://www.findamasters.com/masters-degrees/course/msc-disaster-management-and-sustainable-development-1-year-full-time/?i180d8389c60164
TATA Institute of Social Sciences, Mumbai	MA / MSc—Disaster management	https://www.findamasters.com/masters-degrees/course/master-of-arts-master-of-science-disaster-management-mumbai-campus/?i3729d8877c69517
University of Manchester	MSc—International disaster management	https://www.findamasters.com/masters-degrees/course/msc-international-disaster-management/?i332d4473c28896
	MSc—International disaster management and humanitarian response	https://www.findamasters.com/masters-degrees/course/msc-international-disaster-management-and-humanitarian-response/?i332d4473c61743
University College London (UCL)	MSc / PG dip—Earthquake engineering with disaster management	https://www.findamasters.com/masters-degrees/course/earthquake-engineering-with-disaster-management-msc-pg-dip/?i274d1826c20036
	MSc / PG dip—Engineering for international development	https://www.findamasters.com/masters-degrees/course/engineering-for-international-development-msc-pg-dip/?i274d1826c35277
	MSc / PG cert—Space risks & disaster reduction	https://www.findamasters.com/masters-degrees/course/space-risks-and-disaster-reduction-msc-pg-cert/?i274d1844c45247
	MRes—risk and disaster reduction	https://www.findamasters.com/masters-degrees/course/risk-and-disaster-reduction-mres/?i274d8712c24436
	MSc / PG dip—Risk, disaster and resilience	https://www.findamasters.com/masters-degrees/course/risk-disaster-and-resilience-msc-pg-dip/?i274d8712c40321
University of Bristol	MSc—Earthquake engineering and infrastructure resilience	https://www.findamasters.com/masters-degrees/course/earthquake-engineering-and-infrastructure-resilience-msc/?i287d6200c48844
University of Derby	MSc—Intelligence, security and disaster management	https://www.findamasters.com/masters-degrees/course/intelligence-security-and-disaster-management-msc/?i295d3397c50014
University of Twente	MSc—Geo-information science and earth observation	https://www.findamasters.com/masters-degrees/course/geo-information-science-and-earth-observation-msc/?i754d8913c70327
Van Hall Larenstein, University of Applied Sciences	MSc—Management of Development—Specialisation disaster risk management	https://www.findamasters.com/masters-degrees/course/master-of-management-of-development-msc-specialisation-disaster-risk-management/?i962d6062c22679

deadlines, following its own pace, and allow even getting a certificate for reasonable money after a successful completion of the course.

3.4 Selected Summer Schools on Landslides

A search in January 2023 in the Web of Science Core Collection (Clarivate Analytics 2023) using a search combination

“summer schools” AND “landslide” yield only 7 hits, among those the following ones presented below.

- One-week Innsbruck Summer School of Alpine Research 2015 on close-range sensing techniques in Alpine terrain in Obergurgl, Austria, by an international team from several universities and research centers (Rutzinger et al. 2018). Of the applicants, a group of 40 early career researchers was selected with interest in about ten types

Table 3 The Master and PhD degrees covering the topic of landslides as of early February 2023, using the FindAMaster platform (www.findmasters.com) and Keystone Masterstudies platform (www.masterstudies.com), sorted by the institution name

University	Title of the program	Source
Aberdeen University, UK	MSc—Advanced mechanical engineering	https://www.findmasters.com/masters-degrees/course/advanced-mechanical-engineering-msc/?i2d4439c46741
Cardiff University, UK	MSc—Environmental hazards	https://www.findmasters.com/masters-degrees/course/environmental-hazards-msc/?i33d2698c59177
Durham University, UK	MA—Environmental Hazards & Risk	https://www.findmasters.com/masters-degrees/course/ma-environmental-hazards-and-risk/?i67d5259c69422
	MSc—Environmental Hazards & Risk	https://www.findmasters.com/masters-degrees/course/msc-environmental-hazards-and-risk/?i67d5259c69423
Hong Kong University of Science and Technology, China	MPhil—Civil engineering	https://www.findmasters.com/masters-degrees/course/master-of-philosophy-in-civil-engineering/?i1175d8726c66299
Massey University, New Zealand	MSc—Geography	https://www.findmasters.com/masters-degrees/course/msc-environmental-hazards-and-risk/?i67d5259c69423
Newcastle University, UK	MPhil—Civil engineering (water resources)	https://www.findmasters.com/masters-degrees/course/civil-engineering-water-resources-mphil/?i177d7800c9419
University College London (UCL), UK	MSc—Geophysical hazards	https://www.findmasters.com/masters-degrees/course/geophysical-hazards-msc/?i274d1839c20112
Université Côte d’Azur, France	MSc—Environmental hazards and risk management	https://www.findmasters.com/masters-degrees/course/msc-in-environmental-hazards-and-risk-management/?i336d8370c62864
University of Otago, New Zealand	MAppSc—Applied geology	https://www.findmasters.com/masters-degrees/course/master-of-applied-geology-mappsc/?i653d6470c58949
	MSc—Geology	https://www.findmasters.com/masters-degrees/course/master-of-geology-msc/?i653d6470c58981
University of Padua, Italy	Water and geological risk engineering	https://www.findmasters.com/masters-degrees/course/water-and-geological-risk-engineering/?i1283d7794c63814
University of Pavia, Italy	MSc—Environmental engineering—Reach: REsilience to climAte CHange effects	https://www.findmasters.com/masters-degrees/course/environmental-engineering-curriculum-in-reach-resilience-to-climate-change-effects/?i1940d8374c68290
	MSc—Civil engineering for mitigation of risk from natural hazards	https://www.masterstudies.com/Master-degree-in-Civil-Engineering-for-Mitigation-of-Risk-from-Natural-Hazards/Italy/Uni-Pavia/
University of Plymouth, UK	ResM—Geological sciences	https://www.findmasters.com/masters-degrees/course/resm-geological-sciences/?i341d764c63976
University of Portsmouth, UK	PhD—Environment, geography and geosciences	https://www.findmasters.com/masters-degrees/course/environment-geography-and-geosciences-distance-learning-phd/?i343d750c65336
	MSc—Geological and environmental hazards	https://www.findmasters.com/masters-degrees/course/geological-and-environmental-hazards-msc/?i343d750c492

of specialized surveying tools, i. e. laser scanners, a remotely piloted aircraft system, a thermal camera, a backpack mobile mapping system, and different grade photogrammetric equipment.

- The Geoinformatics Building Technology and Research Centre, Department of Civil Engineering, Chitkara University, Himachal Pradesh organized a “Natural Resource Database Management System—Department of Science and Technology (NRDMS—DST) sponsored 21-day Summer School on Geospatial Technologies (Level 2) Mountain Disaster Management—Landslide” from 9 to 29th May 2019 (Prakasam et al. 2022). The theme of the training programme was “Landslide Disaster Management and Modelling through various geospatial technologies, hands-on approach, and field training”. Participants from

various backgrounds, such as researchers, academicians, scientists, administrative staff, NDMA & NDRF officers, have been selected to attend the summer school. The training programme mainly focused on various aspects of landslides, such as vulnerability and risk assessment, slope stability assessment and stabilization measures, field techniques for collecting data, and high-resolution 2D and 3D modelling.

- A Summer School on “Landslides and Slope Stability Analysis in Rwanda” took place in 2022 at Rwanda Polytechnic—College of Musanze (Rwanda) (Valentino et al. 2023). The Summer School was organized by the hosting institution (Rwanda Polytechnic—College of Musanze) in cooperation with the University of Parma (Italy), Rwanda Water Resources Board (RWB), and

Table 4 The selected master's degrees in emergency & Disaster Management as of early February 2023, using the Master portal platform (www.mastersportal.com), sorted by the institution name

University	Title of the program	Source
Georgetown University, Washington D.C, USA	Master—International emergency and disaster management	https://www.mastersportal.com/studies/363581/international-emergency-and-disaster-management.html
National Taiwan University, Taipei, Taiwan	MSc—Disaster risk reduction and resilience	https://www.mastersportal.com/studies/367568/disaster-risk-reduction-and-resilience.html
University College London, London, United Kingdom	MSc—Risk and disaster science	https://www.mastersportal.com/studies/270375/risk-and-disaster-science.html
	MSc—Risk, disaster and resilience	https://www.mastersportal.com/studies/41933/risk-disaster-and-resilience.html
	MSc—Risk and disaster reduction	https://www.mastersportal.com/studies/41598/risk-and-disaster-reduction.html
University of Canterbury, Christchurch, New Zealand	Master—Disaster, risk and resilience	https://www.mastersportal.com/studies/320283/disaster-risk-and-resilience.html
University of Manchester, Manchester, United Kingdom	MSc—International disaster management	https://www.mastersportal.com/studies/72553/international-disaster-management.html
University of Newcastle, New South Wales, Australia	Graduate certificate—Disaster risk reduction	https://www.mastersportal.com/studies/299561/graduate-certificate-in-disaster-risk-reduction.html
York University, Toronto, Canada	Master—Disaster and emergency management	https://www.mastersportal.com/studies/91066/disaster-and-emergency-management.html

Table 5 The master's degrees that offer courses on slope stability and landslides as of early February 2023, using the Google search platform (www.google.com), sorted by the institution name

University	Title of the program	Course on Landslides	Source
EPFL, Lausanne, Switzerland	MSc—Civil engineering	CIVIL-530 slope stability	https://edu.epfl.ch/coursebook/en/slope-stability-CIVIL-530
National Graduate Institute for Policy Studies (GRIPS), Tokyo, Japan	Master – Disaster management	Control measures for Landslide & Debris Flow	https://www.grips.ac.jp/en/education/inter_programs/disaster/
Norwegian University of Science and Technology (NTNU), Norway	MSc—Geotechnics and Geohazards & MSc—Geotechnology	TGB4290 landslides	https://www.ntnu.edu/studies/courses/TGB4290
		TBA5150 Geohazards and risk	https://www.ntnu.edu/studies/courses/TBA5150
University of Geneva, Switzerland	Specialisation certificate for the assessment and Management of Geological and Climate Related risk	Landslide risk module	https://www.unige.ch/sciences/terre/CERG-C/training/terrain/
University of Calgary, Alberta, Canada	MSc—Civil engineering	ENCI 675 landslides and slope stability	https://contacts.ucalgary.ca/info/enci/courses/f21/ENCI675
University of Genoa, Italy	MSc—Engineering for natural risk management	94,641 landslide hazards	https://corsi.unige.it/en/off.f/2021/ins/51119
University of Pavia, Italy	MSc—Civil Engineering for Mitigation of Risk from Natural Hazards	GEO05 landslide hazard and risk	http://civrisk.unipv.it/hyris/landslide-hazard-and-risk-2/
University of Pennsylvania, USA	MSc—Applied geoscience	GEOL 672690 Landslides	https://www.lps.upenn.edu/courses/landslides/2021a
University of Twente, Netherlands	MSc—Geo-information science and earth observation	Data-driven Hazard modelling Disaster risk management Physically-based Hazard modelling	https://studyguide.itc.nl/m-geo/all-courses/201800282/data-driven-hazard-modelling https://studyguide.itc.nl/m-geo/all-courses/201800304/disaster-risk-management https://studyguide.itc.nl/m-geo/all-courses/201800289/physically-based-hazard-modelling
University of Wisconsin—Madison, USA	Interdisciplinary professional program	Slope stability and landslides	https://interpro.wisc.edu/courses/slope-stability-and-landslides/
Western University, Ontario, Canada	MSc—Civil and environmental engineering	CEE9621a landslides and slope stability	https://www.eng.uwo.ca/civil/graduate/current_students/graduate_courses/CEE-9621a-2020-outline.pdf

Table 6 The Massive Open Online Courses (MOOCs) also covering topics on slope stability and landslides as of mid-February 2023, using the Google search platform (www.google.com), sorted by the institution name

Institution	Title of the MOOC	Source
EO4GEO alliance & ISPRA, Italy	Landslide affecting cultural heritage sites—Roman Thermae of Baia	http://www.eo4geo.eu/training-actions/eo4geo-mooc/
École Polytechnique Fédérale de Lausanne (EPFL), Lausanne, Switzerland	A resilient future: Science and technology for disaster risk reduction	https://www.edx.org/course/a-resilient-future-science-and-technology-for-disa
Hong Kong University of Science and Technology (HKUST), China	Slope engineering—understanding landslides using slope engineering concepts.	https://www.hkmooc.hk/courses/HKUST+CIVIL-slope
GEOMAR Helmholtz Centre for Ocean Research, Kiel & Kiel University, Germany	One planet—One ocean: From science to solutions—Part on 5.3 submarine landslides and tsunamis	https://www.edx.org/course/one-planet-one-ocean
TH Köln—University of Applied Sciences, Germany—regional climate and disaster resilience e-learning platform	EDRR001: Disasters and ecosystems: Resilience in a changing climate	https://courses.adpc.net/courses/course-v1:CNRD+EDRR001+2017_T1/about
University of Alaska, Fairbanks, USA	Synthetic aperture radar: Foundations	https://www.edx.org/course/sar-foundations
University of Alaska, Fairbanks, USA	Synthetic aperture radar: Hazards	https://www.edx.org/course/sar-hazards
University of Alaska, Fairbanks, USA	Synthetic aperture radar: Ecosystems	https://www.edx.org/course/sar-ecosystems
University of Alaska, Fairbanks, USA	Professional certificate in SAR: Applications	https://www.edx.org/professional-certificate/alaskax-synthetic-aperture-radar-sar-applications
University of Pittsburgh, USA	Disaster preparedness	https://www.coursera.org/learn/disaster-preparedness
UN Environment Programme (UNEP) & Partnerships for Environment and Disaster Risk Reduction (PEDRR)	Certificate course on nature-based solutions (NbS) for disaster and climate resilience	https://pedrr.org/mooc
UN Office for Outer Space Affairs (UNOOSA) & Centre for Space Science & Technology Education in Asia and the Pacific (CSSTEAP)	Geospatial applications for disaster risk management	https://www.preventionweb.net/news/mooc-geospatial-applications-disaster-risk-management

Rwanda Transport Development Agency (RTDA) in the framework of the Erasmus + EnRHed project (<https://enrhed-erasmusplus.com/>) (Petrella et al. 2022).

The EnRHed project (“Enhancement of Rwandan Higher Education in strategic fields for sustainable growth”) was co-funded by the European Commission and is coordinated by the University of Parma. Among the strategic fields for sustainable development, this project deals with “Environmental protection, safety, and management.” In this domain, the topic of landslides plays a fundamental role, especially referring to the Rwandan context. It was the first time such a kind of Summer School on slope stability analysis took place in Rwanda. Besides the organizing institutions, the Summer School was supported by many other sponsors, like ICL—International Consortium on Landslides, AIGeo—Italian Association of Physical Geography and Geomorphology, IAH Italian Chapter—International Association of Hydrogeologists, Rocscience Inc., and the University of Parma.

Also search in abstracts, titles and keywords in the SCOPUS database using terms “summer school”, “landslide”, “debris flow”, and “mass movement” revealed no new hits compared to the Web of Science database.

Nevertheless, summer schools are popular forms of training, especially for post-graduate (master) and doctoral (Ph.D. and post-doc) students and young researchers in general. In July 2016, a post-graduate training school on landslides and other geological hazards in active volcanic environments was offered in the Azores, Portugal (<https://formose2016.wixsite.com/formose2016>). In 2019, a summer school was organised in NE Italy for early-career scientists on historic and prehistoric landslides in the northern Italian Alps with implications for new hazard maps in mountainous areas. In July 2024, as a forerunner to the 14th International Symposium on Landslides to be held in Chambéry, France (<https://www.isl2024.com/>), a short summer school is offered on an overview of the fundamentals of slope engineering.

3.5 Landslide-Related Capacity Building Examples

There are a few international summer schools closely related to landslide research and mitigation worth being mentioned specifically. The first one is a summer school in Europe, and the other two are organized in Asia. It follows a list of more than a dozen landslide-related capacity-building cases—among others the ICL initiative for a landslide school network, ICL Teaching Tools, ICP/IPL World Report on Landslides, and further educational materials (blogs, portals, platforms, databases, lectures).

3.6 Case 1: The International School on Landslide Risk Assessment and Mitigation (LARAM)

The International School on “LAndslide Risk Assessment and Mitigation” (LARAM, <http://www.laram.unisa.it>), was founded in 2005 as a pioneering didactic and research initiative of the Geotechnical Engineering Group of the University of Salerno (Cascini et al. 2012). The main activity of LARAM is a yearly 2-week School for Ph.D. students and Young Doctors. The main objectives of LARAM are to develop high educational interdisciplinary programs for assessing, forecasting, and mitigating landslide risk at different scales and to promote the creation of training programs aimed at solving real landslide risk problems using the most advanced theories and methodologies in the fields of geotechnical engineering, geomechanics, geology, physical geography, mathematical modelling, monitoring, GIS techniques, risk management, and other relevant topics. Other initiatives include shorter courses, scientific sessions and workshops, research projects and other dissemination activities (Cascini et al. 2021).

Since 2006, 11 editions were held in Salerno, Italy, 3 editions were held in Chengdu, China. More details on the number and geographical distribution of the students selected to participate in the LARAM doctoral school are reported in Cascini et al. (2018). Over 200 Universities provided the doctoral school with 591 Ph.D. students from 2006 to 2018 (Cascini et al. 2019). In 2020, the LARAM school went online (Cascini et al. 2020), and in 2021, the LARAM school was announced on the Landslide Blog (AGU 2021), and in 2022 on the PreventionWeb pages (UNDRR 2022c).

3.7 Case 2: Kokomerem Summer School on Rockslides and Related Phenomena in the Kokomerem River Valley (Kyrgyzstan)

ICL Annual Summer School on Rockslides and Related Phenomena in Kyrgyzstan (Strom 2014) started in 2006 (Strom and Abdrakhmatov 2009, 2013), being supported by the IPL Projects M111, M126 and finally C106-2 (Mikoš et al. 2023). The schools are running ever since 2006, being interrupted only by COVID-19 pandemic (Strom and Abdrakhmatov 2013, 2015a, b, 2018, 2019, 2023).

This training course aims to familiarize students and young landslide researchers with various types of large-scale bedrock landslides (rockslides), with geological factors favorable for their origin and with their primary and secondary effects such as river damming and subsequent outburst floods.

3.8 Case 3: The International Research Association on Large Landslides (iRALL) School

The International Research Association on Large Landslides (iRALL; <http://irall.skjlgp.cdut.edu.cn/index.htm>) was founded in 2015. Its secretariat is located at the State Key Laboratory of Geohazard Prevention and Geoenvironment Protection, Chengdu University of Technology, China. The school was established in 2016 and offers annually high-level courses, focusing on the investigation, analysis, and management of large landslides for Ph.D. students and postdocs from all over the world, with international experts on the research of large landslides as teaching staff. The last edition of iRALL School 2022 offered 4 days introductory courses, cutting-edge progress, and software training. The topics covered landslide hazard identification, earthquake induced landslide mechanism, rainfall induced landslide hydrological control, large-scale debris flow mechanism, glacial hazards, remote sensing, and numerical simulation technology in the application of landslide hazards.

3.9 Case 4: ICL Landslide School Network

In 2011, the International Consortium on Landslides, Kyoto, Japan, initiated a proposal for the ICL Landslide School Network (Karnawati and Yin 2011) as an ICL contribution to worldwide efforts for effective landslide risk reduction. A special 3-page guideline for this network was prepared (ICL 2010) as the network starting point. In 2012, the proposal for the network was upgraded to the ICL Capacity Development Network, coordinated by the University Gadjah Mada, Indonesia (ICL 2012). The last progress report published on

the ICL web pages is from 2018 (<https://www.landslides.org/projects/icl-networks/>).

3.10 Case 5: ICL Landslide Teaching Tools

In 2013, International Consortium on Landslides (ICL) has decided to compile a collection of landslide teaching tools (Sassa et al. 2013) to provide teaching materials to ICL members and other landslide teaching entities to assist in the education of university students, local government officers, staff in nongovernmental organizations, and the public. The teaching toolbox contains five parts (He et al. 2014): (1) mapping and site prediction; (2) monitoring and early warning; (3) testing and numerical simulation; (4) risk management; and (5) country practices and case studies. The teaching toolbox contains three types of tools: (1) TXT tools consisting of original texts with figures; (2) PDF tools consisting of already published reference papers, manuals, guidelines, and others; and (3) PPT tools consisting of PowerPoint® files made for lectures.

In 2018, the ICL published the second and quite expanded edition of its landslides teaching tools, providing numerous teaching tools from a variety of international organizations and institutes, and it included guidelines for monitoring, modeling, and capacity development in:

- Volume 1 on fundamentals, mapping, and monitoring (Sassa et al. 2018a), and in
- Volume 2 on testing, risk management, and country practices (Sassa et al. 2018b)

Since the introduction of the ICL open-access book series “Progress in Landslide Research and Technology” (P-LRT) (Sassa 2021b), articles on teaching tools are published in this book series. In P-LRT Volume 1 Issue 1 an article on the software LS-RAPID presenting its manual and video tutorials was published (Ajmera et al. 2023). In P-LRT Volume 1 Issue 2 an article was published on undrained dynamic loading ring shear testing with video (Loi et al. 2023), and an article how to reach remotely the vegetation works to protect slopes against mass wasting by using video materials as a case study in Bhutan (Hirota et al. 2023). In P-LRT Volume 2 Issue 1, an article on the application of LAND-SUITE for zonation of landslide susceptibility in Spain (this volume), and an article on landslide and soil erosion inventory mapping based on high-resolution remote sensing data as a case study in Croatia will be published (this volume). All ICL landslide teaching tools are useful teaching materials for summer schools or higher education curriculum focused on landslide disaster risk reduction.

3.11 Case 6: ICL/IPL World Report on Landslides

The International Consortium on Landslides (ICL) and International Program on Landslides (IPL) created web data base and web cooperation platform for sharing information about landslide case studies in the global landslide community. The idea of World Report on Landslides (WRL) was initiated in 2010, and rules for web publication were defined in 2014 (Abolmasov et al. 2017). This activity was a ICL and IPL contribution to the Sendai Partnership 2015–2030 for Global Promotion of Understanding and Reducing Landslide Disaster Risk (Sassa 2015), and to the Sendai Framework for Disaster Risk Reduction 2015-2030 (UNDRR PreventionWeb 2015).

This platform is still not as active as it might be for the benefit of the world landslide community, also for educators to use it in courses on slope stability and landslides. The advantage of this platform is that it gives an opportunity to publish on the web a very detailed case study with all technical details of a landslide.

3.12 Case 7: UNDRR PreventionWeb Platform

The United Nations Office for Disaster Risk Reduction (UNDRR) offers the PreventionWeb (www.preventionweb.net), the collaborative global knowledge sharing platform for disaster risk reduction and resilience. The site offers a range of knowledge products and services to facilitate the work of DRR professionals. The PreventionWeb features content that helps DRR stakeholders better understand disaster risk and learn from implementing DRR strategies, policies, and measures. There is freely available educational material, for the search on “landslide(s)” with 762 results as of February 2023 (417 news, 247 publications, and 64 events).

The PreventionWeb platform lists academic programmes across the world which offer education on all levels (including bachelor, master, diploma, etc.) related to disaster risk reduction.

Under the topic “Educational materials”, the PreventionWeb platform also offers a variety of children’s books, textbooks, lesson plans, activities, games, and online resources on disaster prevention and school safety—from pre-school and kindergarten level to secondary schools.

3.13 Case 8: United States Geological Survey (USGS) Web Sources

The United States Geological Survey (USGS; <https://www.usgs.gov/>) offers a variety of web tools that can be used for educational purposes in the field of natural hazards, including

for landslide disaster risk reduction and capacity building. There is a short overview of some of the useful tools:

- Global Earthquake-Triggered Ground Failure Inventory Database that includes repository of Earthquake-Triggered Ground-Failure Inventories Web Application (interactive map) and An Open Repository of Earthquake-Triggered Ground-Failure Inventories (data) (USGS 2023a).
- Comprehensive Global Database of Earthquake-Induced Landslide Events and Their Impacts (ver. 2.0, February 2022; Seal et al. 2022; USGS 2023b).
- USGS Public Lecture Series (USGS 2023c) that offer virtual attendance using live streaming of the public lecture over the MSTeams® platform.

3.14 Case 9: NASA Models and Datasets

With actionable Earth observations, the NASA Earth Science Applied Sciences Program empowers communities across the world to find solutions to the challenges they face every day (<https://appliedsciences.nasa.gov/>). One of the projects on this web platform is entitled “Enabling Landslide Disaster Risk Reduction and Response throughout the disaster life cycle with a multi-scale toolbox” (NASA 2023a). This project is a part of NASA landslide research and is advancing landslide hazard assessment and forecasting using machine learning models, satellite data, model products, and post-event information that describes where landslides have taken place. This project provides the only open-source, continually updating model of rainfall-triggered landslide hazards available in near real-time across most of the world.

The global Landslide Hazard Assessment for Situational Awareness (LHASA) model was developed by NASA that combines Global Precipitation Model (GPM; <https://gpm.nasa.gov/>) near real-time precipitation data with a global susceptibility map to generate estimates of where and when rainfall-triggered landslides are likely to occur around the world (NASA 2023b). Information on landslide reports is available on the Cooperative Open Online Landslide Repository (COOLR; <https://gpm.nasa.gov/landslides/>), which combines data from NASA’s Global Landslide Catalog, other landslide inventories and contributions from citizen scientists via the [Landslide Reporter Application](https://maps.nccs.nasa.gov/apps/landslide_reporter/) (https://maps.nccs.nasa.gov/apps/landslide_reporter/).

3.15 Case 10: The Landslide Blog in AGU Blogosphere

The American Geophysical Union (AGU) hosts so-called Blogosphere (<https://blogs.agu.org/>) with numerous blogs,

among them the Landslide Blog (<https://blogs.agu.org/landslideblog/>) run by David Petley of the University of Hull, UK. The Landslide Blog provides commentary and analysis of landslide events occurring worldwide, including the landslides themselves, the latest research, and conferences and meetings.

3.16 Case 11: BeSafeNet Platform

The BeSafeNet initiative, starting in 2003 and promoted by the EUR-OPA Major Hazards Agreement of the Council of Europe, has as a main aim, to better protect people from hazards through better informing them on the causes and the consequences of natural and technological hazards (Micallef et al. 2014). This web platform “BE-SAFE-NET” is a tool for promoting risk culture among populations, focusing on teachers to prepare material for elementary school students (BeSafeNet 2023), also covers natural hazards’ topic on landslides (<https://besafenet.net/hazards/landslides/>)—the page was prepared by CERG—European Centre on Geomorphological Hazards from Strasbourg, France (Maquaire et al. 2009).

3.17 Case 12: The International Society for Rock Mechanics and Rock Engineering (ISRM) Course

The ISRM course on "Prevention methods for Landslides in Rock Masses" is now available in open access (ISRM 2023). The course has four parts, with a total of 24 lectures:

- Part A—Understanding landslides in rock mass (four lectures)
- Part B—Methods for quantifying rock mass (eight lectures)
- Part C—Methods for landslide potential of rock mass (five lectures)
- Part D—Measures for preventing landslides in rock mass (seven lectures)

3.18 Case 13: The LARIMIT Portal

The LaRiMiT (Landslide Risk Mitigation Toolbox; <https://www.larimit.com/>) is an Expert-Based Landslide Mitigation Portal assisting users of identifying cost-effective structural landslide risk mitigation options (Uzielli et al. 2017). It is a technical tool for quick selection of landslide risk mitigation measures, but is not intended to replace detailed, site-specific technical investigations, and as much it is a valuable tool for educational purposes. The toolbox was initially developed

within the framework of the European Union 7th Framework Programme project “SafeLand—Living with landslide risk in Europe: Assessment, effects of global change, and risk management strategies” and further developed by the Norwegian Geotechnical Institute (Kalsnes and Capobianco 2019).

3.19 Case 14: Humanitarian Library

The Humanitarian Library was launched in 2013, and is the only inter-agency, inter-sector, crowd-sourced, and community-moderated platform in the humanitarian space (<https://www.humanitarian.org/>). Among its resources, channels and events, there are 75 hits as of March 2023 related to landslides: 70 resources and five collections. One of the five collections is entitled “Landslide Mitigation and Disaster Risk Management—Case Studies and Good Practice” (Humanitarian Library 2023), it was last updated in 2020 and encompassed eight documents.

3.20 Case 15: The VISUS Methodology

UNESCO is actively engaged in empowering schools and their communities to identify the hazards they are exposed to, map their vulnerabilities and capacities, and enhance school safety. To do so, UNESCO promotes a multi-hazard school safety assessment methodology, namely VISUS (Visual Inspection for Defining Safety Upgrading Strategies) (Grimaz and Malisan 2020). Developed by the UNESCO Chair on Intersectoral Safety for Disaster Risk Reduction and Resilience, SPRINT-Lab, University of Udine, Italy, the methodology provides decision-makers with tools and information, allowing them to make science-based decisions on where and how to invest their available resources for enhancing school safety. The VISUS methodology, which has a strong component in capacity building for decision-makers, technical staff, and universities, has been successfully tested in seven mostly developing countries (UNESCO 2023).

3.21 Case 16: The Twinkl Platform

The Twinkl platform (<https://www.twinkl.co.uk/>) offers free educational materials for parents and young students below 18 years of age, on a variety of topics, including natural hazards.

4 Conclusions

The importance of education for landslide disaster risk reduction is clear and unequivocal. The education for natural disaster risk reduction should start as early as possible, even

in the kindergarten (preschool) level and should be offered as a life-long education topic for wider society. The topic of landslide disaster risk reduction in all its variety and depth comes to complete coverage in the curricula of higher education institutions. This topic is widely covered in undergraduate and graduate study programmes in engineering (geotechnical engineering, geological engineering, civil engineering, . . .), but also in science programmes (geology, geography, . . .) and social sciences programmes (risk management, disaster management, resilience, risk dialogue . . .). The topic is mainly covered as a constituent part of more general courses, and to a lesser extent, as courses on slope stability and landslides. This is why summer schools on landslide disaster risk reduction are welcome to offer students an opportunity to deepen their understanding and knowledge in this topic, coming from various disciplines. They make it possible to have an inter-disciplinary milieu, and to stimulate cross-sectoral thinking that is important to understand landslides as socio-technical complex system that needs cross-sectoral approach and systems thinking, quite often supported by critical and innovative thinking.

The article gives a short overview of some (selected) courses and study programmes worldwide offering knowledge and competencies for landslide disaster risk reduction. There are though many more higher education study programmes not covered in this overview, as there are thousands of universities around the world. With respect to summer schools on landslides, the overview is more complete, as the offer is not so extensive.

The worldwide landslide community is invited to support efforts for society resilience against landslides by intensifying their efforts for capacity building in parallel to their research activities. For the International Consortium on Landslides (ICL 2023a), the KLC 2020 Commitment for Global Promotion of Understanding and Reducing Landslide Disaster Risk (Sassa 2021a), is a standing support and reminder to be active (also) in the field of capacity building, not only through research, but also education.

The ICL activities, not only in research, but also in capacity building for society resilience, is supporting the implementation of the ninth phase of the UNESCO Intergovernmental Hydrological Programme (IHP-IX) 2022–2029 (UNESCO 2022b).

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