Date of Submission	05/08/2024

IPL Project Proposal Form 2024

1. **Project Title:**

   Multi-scale Landslide Risk Assessment (*MultiLandRisk)*

   Select one of two below.

   (1) New project

2. **Main Project Fields**

   Select the suitable topics. If no suitable one, you may add new field.

   (1) Technology Development

   B. Hazard Mapping, Vulnerability and Risk Assessment

3. **Name of Project leader**

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Core members of the Project

Nicola Casagli- Full Professor, UNESCO Chair on Prevention and Sustainable Management of Geo-hydrological Hazards, Department of Earth Sciences, University of Florence

Federico Raspini – Associate Professor, UNESCO Chair on Prevention and Sustainable Management of Geo-hydrological Hazards, Department of Earth Sciences, University of Florence

Pierluigi Confuorto – Assistant Professor, UNESCO Chair on Prevention and Sustainable Management of Geo-hydrological Hazards, Department of Earth Sciences, University of Florence

Francesco Caleca – PhD student UNESCO Chair on Prevention and Sustainable Management of Geo-hydrological Hazards, Department of Earth Sciences, University of Florence

4. **Objectives:**

The aim of the project is to develop models and procedures for the quantitative risk assessment of landslides at different scales. The aim of the project is the assessment of the expected damage caused by landslides to buildings, infrastructure and cultural heritage as well as the impact of landslides on the population. The project will focus on all components of the risk equation, *i.e.* hazard, vulnerability and exposure, using different methods depending on the work scale and data availability. The assessment will consider current and future land use changes and climate.

5. **Background Justification:**

Understanding the risk associated with natural disasters is Priority 1 of the Sendai Framework for Disaster Risk Reduction 2015 – 2030. Priority 1 states that policies and practices for disaster risk management should be based on an understanding of disaster risk in all its dimensions of vulnerability, capacity, exposure of people and assets, hazard characteristics and the environment. This knowledge can be used for pre-disaster risk assessment, prevention and mitigation, and the development and implementation of adequate preparedness and effective response to disasters. The Kyoto Landslide Commitment 2020, a commitment to the Sendai Framework for Landslides, proposes 10 priority actions, of which Action 2 is dedicated to hazard, vulnerability and risk assessment.

The UNESCO Chair has recently been involved in several national and international projects on quantitative landslide risk assessment at different scales, testing different methodologies for different types of landslides and

elements at risk. Among others, the UNESCO Chair was commissioned by the Italian National Department of Civil Protection to produce the national landslide risk map, while a project funded by the World Bank produced the landslide hazard and risk map for Central Asia.

6. Study Area:

The project will propose a multi scale approach. We will start from the global level and move towards Europe and Italy as first case studies. As part of a multi-scale approach, some local scale case studies will be selected in order to downscale the procedure and increase the resolution.

Depending on data availability and in collaboration with other ICL members, further case studies will then be selected globally.

7. Project Duration:

The project will have a duration of 3 years.

8. Resources necessary for the Project and their mobilization

The UNESCO Chair staff counts 22 members among full, associate, and adjunct professors, plus 11 researchers, 10 technicians, 3 post-doc fellows, 14 PhD students.

The facilities of the research group include laboratories (GIS and thematic mapping laboratory, Remote Sensing laboratory specialized on SAR interferometry, optical multi- and hyperspectral remote sensing, rock and soil mechanics laboratory) and many equipment for landslide survey and monitoring and material analysis such as GBInSAR portable monitoring systems, rock and soil mechanics field and laboratory equipment, advanced geotechnical and hydrogeological modelling software, advanced photogrammetric modelling software, GPS and topographical survey instrumentation, Infrared thermal camera, 3D laser scanner, Ground Penetrating Radar (GPR), UAV equipped with several sensors.

The group has an average yearly research budget of about 5.5 million Euros from research and development projects funded by national and international organizations.

9. Project Description:

This project aims to develop methodologies for a multiscale quantitative landslide risk assessment. Landslide occurrence is constantly increasing due to the climate change scenario, urbanization and deforestation. Therefore, landslide risk assessment represents a powerful tool for risk management and planning mitigation measures.

The proposed research project will focus on the implementation of multi-scale approaches, ranging from the global to the local scale. Notably, this objective is further supported by the new availability of homogenous databases, that may allow for small-scale assessments.

The project will examine all risk components: hazard, vulnerability, and exposure, with the evaluation methods varying based on the analysis scale. For instance, at a global or continental level, landslide hazard should be approximated to landslide susceptibility due to limited temporal information of landslide inventories. On the contrary, at a site-specific scale, landslide hazard can be fully assessed through physically based models and run-out or intensity-frequency analysis. Furthermore, the mapping unit and associated spatial resolution will vary based on the scale of the analysis. Specifically, geomorphologically reliable or regular partitions may be adopted to conduct the various analyses.

Similarly, vulnerability assessments should differ according to the scale. For instance, at a small scale, vulnerability cannot be defined through quantitative approaches due to limited information on exposed elements (*e.g.*, buildings, roads, and population). However, several parameters, such as resilience, can serve as proxies for vulnerability. Given these circumstances, the results and their accuracy will vary. Specifically, the outcomes of risk analysis at a small scale may lack temporal information and primarily focus on identifying risk hotspots or estimating potential

economic losses. In contrast, local-scale studies can provide detailed temporal and spatial information, enabling the creation of precise products for financial and cost-benefit analyses. Local-scale studies can also incorporate dynamic variables such as changes in land use, and climate impacts over time, allowing for a more detailed understanding of risk and informing more effective decision-making processes. As a result, such analyses may support the development of risk reduction strategies and improve the resilience of communities to landslide hazards.

10. Work Plan/Expected Results:

The project is structured into three work packages:

WP1 Literature review of landslide risk assessment

This WP will be dedicated to the literature review of qualitative and quantitative risk assessments conducted at global, regional, continental, national and local scale. The results of the literature review will form the starting point for WP2 and WP3.

WP2 Global, continental and regional landslide risk assessment

This work package is dedicated to the development of methods for rapid landslide risk assessment on a global and regional scale. The procedure will be mainly based on the new availability of homogeneous databases and will utilize data from global initiatives such as the Global Landslide Hazard Map from USGS and NASA, which provides a global overview of landslide susceptibility and the European Ground Motion Service (EGMS), which provides consistent and reliable information regarding natural and anthropogenic ground motion over the Copernicus participating states. The continental assessment will be a first evaluation of landslide risk at small scale to identify hotspot areas. Depending on the data availability and their resolution for each continent, the output will be qualitative or quantitative.

WP3 National and local-scale landslide risk assessment

This WP will be dedicated to the development of models and procedures for quantitative risk assessment at national and local scale. The activity will mainly focus to test, for different case studies and for different types of landslides, hazard and susceptibility model based on statistical and physically based approaches. Vulnerability of elements at risk will be evaluated according to the availability of data, through vulnerability indices, vulnerability/fragility curves or structural resistance. Population exposure as well as monetary value of physical assets will be considered.

The results of the activities carried out in three WPs will be published (at least one publication per year) in the Open Access Book Series P-LRT as well as presented during the yearly ICL/KLC2020 conferences and in the next WLF7. Yearly reports of activities will be submitted to ICL secretariat.

11. Deliverables/Time Frame:

	Year 1			Year 2			Year 3		
	M4	M8	M12	M16	M20	M24	M28	M32	M36
WP1									
WP2									
WP3									
Publications in P-LRT			★			★			★

12. **Project Beneficiaries:** The beneficiaries of this project will be several: Civil Protection offices and institution, Research institutes, Universities, Public administrations, international organizations and in general all the stakeholders involved in landslide risk prevention and management.