Date of Submission	22/04/2026

IPL Project (IPL-Number) Annual Report Form

Period of activity under report
from 1 January 2025 to 31 December 2025

1. **Project Number and Title:**

Multi-scale Landslide Risk Assessment (*MultiLandRisk*)

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**

Veronica Tofani, Associate Professor of Engineering geology
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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
Pierluigi Confuorto – Assistant Professor, UNESCO Chair on Prevention and Sustainable Management of Geo-hydrological Hazards
Francesco Caleca – Postdoc, UNESCO Chair on Prevention and Sustainable Management of Geo-hydrological Hazards

4. **Objectives** (5 lines maximum)

The project aims to develop models and procedures for the quantitative risk assessment of landslides at different scales. The project estimated potential damage to buildings, infrastructure, cultural heritage, and impacts on people. Specifically, the project will focus on all risk components: hazard, vulnerability, and exposure. The procedures will vary depending on data availability and scale, while also accounting for future changes in land use and climate.

5. **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.

6. Project Duration

The project will last 3 years.

7. Report

1) Progress in the project (30 lines maximum)

The first year of activities of the MultiLandRisk project has seen a detailed literature review on landslide risk assessment and the implementation of a continental risk analysis for the Pan-European Landscape. The literature review highlighted a clear trend: to date, most landslide risk studies focus on individual slopes or catchments, while regional or continental assessments are rarely performed. The main reason behind this pattern is methodological and data limitations.

In light of these considerations, the practical activities relied on the production of a quantitative landslide risk assessment for the Pan-European landscape. By focusing on the main mountainous ranges of Europe, the activities were directed to estimate potential economic losses to human properties (buildings and agricultural areas). The analyses were based on a meaningful geomorphological partition of the landscape: slope units (SUs). The study area was divided into 570,635 SUs with a mean planimetric area of 3.6 km^2. Each SU represented the prediction target of a data-driven model to identify the areas more inclined to experience landslides. In short, the model predicted the spatial probability of landslide occurrence (i.e., susceptibility) for the whole study area. To do that, 17 landslide inventories were collected from national or regional databases. However, the heterogeneity of landslide inventories introduced a spatial bias within the modelling framework. To treat and correct it, the model was equipped with a bias correction scheme to provide reliable outcomes. The independent variables of the model were represented by geomorphological factors, lithological and land use maps, seismological and meteorological data. The result of the susceptibility modelling indicated the Alps, the Apennines, the Pyrenees, and the Carpathians as the areas more inclined to experience landslides from a statistical perspective.

The second part of the analysis was focused on defining the spatial distribution of elements at risk and then estimating the potential economic losses (risk). The spatial coverage (m^2) as well as the market value (€/m^2) of elements at risk were computed using open data like the GHS-BUILT-S and the CORINE Land Cover datasets. Conversely, their vulnerability was set as maximum due to data limitations. The integration of susceptibility and monetary exposure allowed for defining landslide risk in quantitative terms for the study area. The risk estimates reported a maximum value of 8,383 €/m^2 and a mean risk of 1.04 €/m^2. Considering the whole

extension, the total risk reached 2.3 trillion €. Overall, the highest potential losses were mainly concentrated along the Alpine and Apennine domains. To complement this information, the distribution of the population at risk was analyzed during the daytime and nighttime.

2) Planned future activities or statement of completion of the Project (15 lines maximum)

   The future activities of MultiLandRisk will be focused on the implementation of regional and/or national landslide risk assessments. Specifically, the efforts will be directed into improving both the hazard and vulnerability assessment. In the context of landslide hazard, future perspectives should consider the modelling of the probability of landslide occurrence at least in both space and time. This achievement will partially satisfy the definition of landslide hazard and will provide more reliable products.

   Regarding the vulnerability assessment, future activities should define a procedure for quantitatively estimating this component. To do that, landslide intensity should be defined as a function of landslide magnitude and kinematics. Moreover, vulnerability is also a function of the elements 'characteristics. As a result, databases on the type of elements and their structural characteristics will be collected. The integration of both landslide intensity and elements 'characteristics will allow for defining the vulnerability. By addressing these points, the procedures and related outcomes will benefit from these improvements.

3) Beneficiaries of Project for Science, Education and/or Society (15 lines maximum)

   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.

4) Results (15 line maximum, e.g. publications)

   The results obtained from this year of activities have been summarized in two products: a scientific contribution and a WebApp. The scientific contribution titled "*Pan-European Landslide Risk Assessment: From Theory to Practice*" (https://doi.org/10.1029/2023RG000825) is published in *Reviews of Geophysics*, which has a current impact factor of 37.3. Furthermore, the outputs generated by the activities can be visualized and inspected at the following WebApp: https://pan-european-landslide-risk.github.io/.

Note:

1) If you will change items 2-6 from the proposal, please write the revised content in Red.
2) Please fill and submit this form to ICL Network <icl-network@landslides.org>
3) Reporting year must be one or two years (Maximum).