Date of Submission	

IPL Project Proposal Form 2025

(MAXIMUM: 3 PAGES IN LENGTH)

1. **Project Title: "Harmonized cross-border mass-movement susceptibility mapping for earthquake induced rockfall modeling at the Italy-Slovenia border"**
2. Select one of two below.
   (1) New project X
   (2) Second stage of ongoing project
3. **Main Project Fields**

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

   (1) Technology Development

   A. Monitoring and Early Warning, B. Hazard Mapping X, Vulnerability and Risk Assessment

   (2) Targeted Landslides: Mechanisms and Impacts

   A. Catastrophic Landslides, B. Landslides Threatening Heritage Sites

   (3) Capacity Building

   A. Enhancing Human and Institutional Capacities

   B. Collating and Disseminating Information/ Knowledge

   (4) Mitigation, Preparedness and Recovery

   A. Preparedness, B. Mitigation, C. Recovery
4. **Name of Project leader:** Antonella Peresan

   Affiliation: OGS, Senior Researcher (office and position)

   Contact: Via Treviso 55, 33100 Udine Italy, +39 0402140154 (postal address, fax, phone, email)

   Core members of the Project: National Institute of Oceanography and Applied Geophysics, OGS (Italy); Geological Survey of Slovenia (GeoZS)

   Names/Affiliations: (4 individuals maximum) Antonella Peresan (OGS - ICL deputy board member); Rachele Franceschini (OGS); Mateja Jemec Auflič (GeoZS) and Gisela Domej (GeoZS)
5. **Objectives**: To develop harmonized landslide/rockfall susceptibility maps across the Italy–Slovenia border using a shared methodology. The project aims to improve transnational hazard assessment in a multi-risk perspective, to support territorial and emergency planning, and to contribute to the identification of priority areas for real-time monitoring and civil protection interventions.
6. **Background Justification**: The Italy–Slovenia border region is highly susceptible to landslides and rockfalls due to its complex geology, steep topography, active tectonic setting and increasing climatic extremes. Currently, heterogeneous mapping methods and data standards between countries hinder coordinated risk management. A harmonized approach is essential to produce comparable susceptibility assessments, integrate seismic hazard factors, and support cross-border decision-making. The initiative addresses gaps in inventory quality, methodological alignment, and data interoperability, enhancing both prevention and response capacities in seismically active mountain areas.
7. **Study Area**: The border area between the Friuli Venezia Giulia Region (Italy) and Slovenia
8. **Project Duration**: 2 years

9. **Resources necessary for the Project and their mobilization**

Personnel, Facilities, and Budgets

Personnel: 7 persons (3 senior researchers; 3 researchers; 1 research fellow)

Facilities: OGS Seismic Network SMINO for earthquake monitoring and related earthquake data; OGS GNSS network FREDNET for geodetic monitoring and landslides monitoring. GeoZS manages the online "Natural laboratories" monitoring system including 2 landslide and one rockfall monitoring stations.

Budgets: **140.000** € (Approximately 120.000 € is funded by the European Union within the CONCORDIA Interreg Italy-Slovenia project. Part of the funding for GeoZS in provided by the Slovenian Research and Innovation Agency (ARIS) via funding of program groups Regional Geology and Dynamic Earth).

10. **Project Description**:

The border region between Italy and Slovenia is characterized by high landslide and rockfall susceptibility due to complex geological and geomorphological conditions. The combination of heterogeneous soils, tectonic structures, and mountainous to hilly terrain makes the area particularly prone to frequent and sometimes severe slope instability events. Moderate to rather high seismicity occurred the study area, including the 1976 Friuli earthquake (M6.5), on the Italian side, and the 1998 Bovec (M5.6) earthquake, on the Slovenian side, which triggered numerous rockfalls. Human pressures further increase exposure, especially in high-risk mountain zones. Climate change exacerbates the situation through more intense and sudden rainfall, leading to rapid soil saturation, reduced slope stability, and accelerated erosion.

Despite the shared risks, landslide susceptibility maps and hazard assessments remain fragmented across the border, with differences in scale, methodology, and data coverage. This lack of harmonization undermines effective cross-border planning and emergency response. The project aims to address these gaps by developing unified susceptibility maps based on a harmonized methodology and by integrating geophysical parameters to enhance hazard modelling. The OGS contributes through its expertise in seismic hazard assessment and geophysical monitoring, supporting the integration of dynamic seismic parameters into landslide susceptibility models. GeoZS contributes through its expertise in mass-movement susceptibility assessment. Key activities include:

- forward modelling of earthquake ground shaking and rockfall/landslide scenarios;
- analysis of correlations between ground shaking and rockfalls triggering;
- assessment of aftershock influence on rockfall hazard as a time-dependent process.

The project also includes rockfall run-out modelling and the generation of impact maps showing the likelihood of road damage following seismic events. These tools will directly support civil protection agencies in identifying safe intervention routes and optimizing emergency response strategies.

By addressing current methodological gaps and strengthening data and operational integration, the project will contribute to reducing landslide risk and building resilience to both climatic and seismic hazards in this transborder region.

11. **Work Plan/Expected Results**:

The main objective is to create harmonized cross-border susceptibility maps for landslides and rockfalls in the Italy–Slovenia region, based on a common methodology that improves comparability and supports disaster risk management and planning.

Phase 1 (Months 1–9):

Led by OGS and partners, the project will review national mapping approaches, identify key geological and

cartographic datasets, define relevant susceptibility parameters (e.g., lithology, slope, tectonic features), and assess data gaps. This phase sets the groundwork for a harmonized mapping strategy.

Phase 2 (Months 10–15):

OGS and GeoZS will contribute to building a shared inventory of validated landslides and rockfalls by integrating regional and national databases. A minimum set of common attributes, quality criteria, and metadata standards will be established, ensuring consistency across borders.

Phase 3 (Months 16–24):

A harmonized susceptibility mapping methodology will be implemented, with a key innovation being the integration of seismic shaking parameters (Alvioli et al., 2023: Peresan et al., 2025). Historical seismic events—such as the 1976 Friuli and 1998/2004 Bovec earthquakes—will support calibration and case studies. Maps will be validated against the compiled inventory and refined accordingly. Final deliverables include a current overview report, harmonized susceptibility maps, and a methodological report.

12. **Deliverables/Time Frame**:

    D.3.1.1 (Months 9): Comparative report on national methodologies, mapping parameters, and available geological/cartographic datasets.

    D.3.1.2 (Months 15): Joint inventory of landslides and rockfalls, including agreed attribute sets, metadata standards, and data quality requirements.

    D.3.1.3 (Months 24): Final report on harmonized cross-border susceptibility mapping methodology, with integration of seismic shaking parameters and validated map outputs.

    All deliverables that may contribute to support transnational risk management and will be made available for publication and possible use by relevant stakeholders.

13. **Project Beneficiaries**:

    Project beneficiaries include local, regional, and national public authorities responsible for civil protection and land management, higher education and research institutions involved in geohazard studies, sectoral agencies monitoring natural hazards, and the general public who benefit from improved safety and risk awareness.

14. **References (Optional):**

    1) Alvioli, M., Poggi, V., Peresan, A., Scaini, C., Tamaro, A., Guzzetti, F. (2023). A scenario–based approach for immediate post–earthquake rockfall impact assessment. Landslides 21, 1–16 (2024). https://doi.org/10.1007/s10346-023-02127-2
    2) Peresan, A., Alvioli, M., Zuccolo, E., Vaccari, F., & Badreldin, H. (2025). An approach to rockfall hazard scenarios based on earthquake ground motion. Progress in Landslide Research and Technology, Volume 3 Issue 2, 2024 (pp. 107-117). Cham: Springer Nature Switzerland.
    3) Šegina E., Jemec Auflič M., Mikoš M., Bezak N. (2024). A preliminary investigation of the small rockfall triggering conditions along a road network in Slovenia. Landslides 22, 739-751. DOI: 10.1007/s10346-024-02302-z
    4) Jemec Auflič M, Bezak N, Šegina E, Frantar P., Gariano SL, Medved A., Peternel T. (2023). Climate change increases the number of landslides at the juncture of the Alpine, Pannonian and Mediterranean regions. *Scientific reports*, vol. 13, 14 p. https://doi.org/10.1038/s41598-023-50314-x.

Note: Please fill and submit this form by 15 August 2025 to:

KLC secretariat <klc2020@landslides.org> and ICL Network <icl-network@landslides.org>