Date of Submission	August 2, 2024

IPL Project Proposal Form 2024

(MAXIMUM: 3 PAGES IN LENGTH)

1. Project Title: **Rock failures in coastal carbonate cliffs: susceptibility, hazard assessment and monitoring**

   Select one of two below.

   (1) New project

   (2) Second stage of ongoing project

2. 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, 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

3. **Name of Project leader: Isabella Serena Liso**

   Affiliation: Earth and Environmental Sciences Department, University Aldo Moro, Bari, Italy; researcher

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   Core members of the Project

   Names/Affiliations: Mario Parise, Piernicola Lollino, Gioacchino Francesco Andriani, Giuseppe Mastronuzzi (all of them belonging to Earth and Environmental Sciences Department, University Aldo Moro, Bari, Italy)

4. Objectives: (5 lines maximum; what you expect to accomplish?)

   - ✓ **Identification of sites affected by coastal cliff instability in carbonate rock masses;**
   - ✓ **Study of preparatory and triggering conditions of failures, with particular regard to the effects of seastorms and karst processes;**
   - ✓ **Identification of the hydrogeological and geotechnical variables affecting landslide susceptibility;**
   - ✓ **Modelling of coastal failures;**
   - ✓ **Susceptibility and hazard mapping in test areas;**
   - ✓ **Information dissemination and guidelines to managing authorities and local communities.**

5. Background Justification: (10 lines maximum)

   Coastal instability interests long stretches of the Italian coasts, as well as of the neighbouring countries in the Mediterranean Basin. Given the strong presence of carbonate cliffs in Apulia (SE Italy) the project will be focused on this type of rock masses, where also karst processes play a predisposing role, due to formation and evolution of underground voids; these, combined with the effect deriving from

seastorms, bring to many situations of danger for people and infrastructures, especially during the summer season, when Apulian coasts are intensely frequented by tourists. Assessing the susceptibility/hazard to coastal cliff instability is therefore a crucial point in the management of the land, aimed at safeguarding both people and economic activities related to tourism. Through real case studies, monitored by our group since a few years, we will establish guidelines for a correct approach to the problem, also to suggest the most suitable monitoring actions.

6. Study Area: (2 lines maximum; where will the project be conducted/applied?)

   The first test sites are located in Southern Italy, with subsequent data gathering and statistical analyses at further sites throughout Italy, and possibly the Eastern Adriatic Coast.

7. **Project Duration: 3 years.**

8. Resources necessary for the Project and their mobilization

   Personnel, Facilities, and Budgets

   Members of the core unit (UNIBA) have enough funds to finance the research studies. There are a PhD student and a post-doc researcher actively working on these problems, and several full time professors dealing with geomorphology, engineering geology and geotechnics. UNIBA has passed this year to the status of Full Member of ICL and our will is to strongly cooperate to ICL activities through this new project. Even though the project is initially based only in Bari, we plan to involve other partners belonging to the Italian ICL network, showing a pro-active cooperation between members in this new entity and ensuring a multi-disciplinary approach to such a big item. Involvement of other ICL members from the Eastern Adriatic coast (Croatia, Montenegro, Greece, etc.) is also envisaged. The ICL financial support will eventually support disseminations and public engagement activities such as a specific website and/or through social media platforms, periodic dissemination initiatives and non-technical publications. The project outcomes will represent a solid base of knowledge for further research on coastal failures in carbonate cliffs. The long-term applicability of proposed monitoring methodologies and the development of susceptibility maps requires an integrated and multidisciplinary approach. Long-term application requires constant maintenance and updating of monitoring infrastructures, the collection and analysis of large amounts of data, the modeling of complex phenomena, and the effective communication of results to all stakeholders. It is essential to invest in research and development of new technologies, ensure long-term economic sustainability, involve all interested parties, and adopt an adaptive approach to climate and environmental changes.

9. Project Description: (30 lines maximum)

   The collection of coastal rock failure events represents the first step to reach the project goal. This includes multi-temporal analyses, through the use of ancillary datasets (terrestrial and aerial photos, orthophotos, point clouds from previous surveys, existing inventories of rock failures, etc.), that will allow to identify the most interesting sites where to deepen the research, also by performing laboratory and field tests on rock samples. As a second step, statistical analyses of the main storm events impacting the cliffs will be carried out to identify potential correlations between storm and rock failures. Starting from the identification of the possible kinematics of failures, and once the predisposing, preparatory, and triggering factors have been identified on a time-dependent basis, susceptibility models will be implemented to produce related maps, which will bring, by means of additional historical data about already occurred failures, to estimate the coastal instability hazard.

   At the same time, active monitoring systems (extensimeters and GPS at specific sites, thermal surveys,

rain gauge and tide and wave loggers) will provide data to well define the main factors intervening in the different stages of evolution, from predisposition, to preparation, until triggering the failures. The study site has already been equipped with the most of the before mentioned monitoring instruments (extensimeters, GPS, rain gauge) while the remaining will be installed soon. Moreover, in cooperation with the local municipality, it is scheduled to install a real-time warning system along the cliffs, given the proximity of the main communication routes and of several buildings to the coastline. Based upon the availability of specific geological, geomorphological, geotechnical and hydrogeological data, 2D and 3D modeling will be used by considering different settings, from finite element analyses to discrete element analysis, depending upon the presence and pervasiveness of discontinuity systems in the rock mass. These applications will define a variety of possible behaviors of the carbonate rock mass, also useful for the selection of the most appropriate mitigation strategies and stabilization works. Further efforts will be done aimed at understanding the role played by the presence of karst caves and conduits, as well as by the main direction and energy of sea waves during storms and the rainfall regime in both the preparation and trigger of coastal landslides. Eventually, the connection with several managing authorities, at the local and regional levels, will allow to transfer the obtained knowledge to the local community, with the goal to mitigate the societal risk linked to this type of phenomena.

The results of the activities carried out in the WPs will be published in the Open Access Book Series P-LRT as well as presented during the yearly ICL/KLC conferences. Yearly reports of activities will be submitted to ICL secretariat.

10. Work Plan/Expected Results: (30 lines maximum; work phases, milestones and publication)
    including the contribution plan of articles on the IPL project (progress/result) to the Open Access Book Series P-LRT in the coming few years.

    The project encompasses sequential stages, and will be divided into 4 main Work Packages: Wp1 - on-site surveys and laboratory/monitoring tests, Wp2 - GIS inventory, and hazard and risk mapping, Wp3 - numerical modelling, and WP4 - dissemination and guidelines. The timetable, subdivided on a monthly basis, is as follows:

TIME		WP			
YEAR	MONTH	WP1	WP2	WP3	WP4
1	January				
	February				
	March				
	April				
	May				
	June				
	July				
	August				
	September				
	October				
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2	January				

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	August				
	September				
	October				
	November				
	December				

11. Deliverables/Time Frame: (10 lines maximum; what and when will you produce?)

    During the first year, the selection of sites affected by slope instability will be done, and rock sampling and laboratory and field tests will be conducted. A database on the study areas will be constructed and populated.

    In the second year, 2 and 3D-numerical modelling, also based upon the results obtained from monitoring systems,and GIS analyses will be performed.

    The last year will be particularly devoted to the production of thematic maps, guidelines and to dissemination of the acquired knowledge among land managers and authorities and the local communities.

12. Project Beneficiaries: (5 lines maximum; who directly benefits from the work?)

    Local and regional bodies and authorities (Municipalities, Regions, Civil Protection, etc.) responsible for human safety at the local and regional scale; landslide professionals, researchers, planners and people living near areas affected by coastal cliff instability. Tourist managers and society, whose activities and economies might be negatively impacted by cliff instability problems.

13. References (Optional): (6 lines maximum; i.e. relevant publications)

Lollino P., Pagliarulo R., Trizzino R., Santaloia F., Pisano L., Zumpano V., Perrotti M. & Fazio N.L. (2021) Multiscale approach to analyse the evolution of soft rock coastal cliffs and role of controlling factors: a case study in South-Eastern Italy, Geomatics, Natural Hazards and Risk, 12:1, 1058-1081, DOI:10.1080/19475705.2021.1910351.

Note: Please fill and submit this form by 15 August 2024 to:

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