

IPL Project Proposal Form 2022

(MAXIMUM: 3 PAGES IN LENGTH)

1. Project Title: (2 lines maximum)

Monitoring rock glaciers kinematic process using SAR interferometry and offset-tracking in Alpine environment

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

Qingkai Meng¹, Associate Professor in Remote Sensing and Physical Geography

Federico Raspini², Researcher in Physical Geography and Geomorphology

Affiliation: 1 Institute of mountain hazards and environment, Chinese Academy of Science (IMHE-CAS); 2 Earth Sciences Department of the University of Firenze (DST-UNIFI), UNESCO Chair on Prevention and sustainable management of geo-hydrological hazards, University of Florence (UNESCO Chair-UNIFI)

Contact: No.9, Block 4, Renminnanlu Road, Chengdu,(China)-Phone: (028)85235224

Core members of the Project:

Names/Affiliations:

Xiaoqing Chen, Full Professors, IMHE-CAS

Nicola Casagli, Full Professor, DST-UNIFI, UNESCO Chair-UNIFI

Veronica Tofani, Full Professor, DST-UNIFI, UNESCO Chair-UNIFI

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

The main objective of this project is to retrieve surface velocity maps of active rock glaciers in different Alpine environments (*i.e.*, Western Himalaya, Inner Qinghai-Tibet and Alps) using Interferometric and offset-tracking techniques.

5. Background Justification: (10 lines maximum)

Prominent rock glaciers are a visible climate indicator in cold mountain environments. They can also

be the source of rockfalls and debris flows, and eventually evolving into local-scale natural hazards due to warming temperatures and degrading permafrost. Thus, monitoring rock glaciers deformation is considered a valuable tool for risk mitigation. The launch of Sentinel-1 mission has opened a new opportunity to exploit both the phase and amplitude signals of SAR (Synthetic Aperture Radar) acquisitions for the detection of ground displacement. Integration of SAR Interferometrical geodetic with offset-tracking methods accommodate a full spectrum of rock glacier deformation processes from creeping to fast flowing. Leveraging on accessible data, sophisticated data processing and interpretation experience, the final output of the proposed approach will consist on elaborated inventory mapping of active rock glaciers.

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

The study area will be the Karakoram (Western Himalaya), Sanjiangyuan National Park (Qinghai-Tibet) and Valle d'Aosta (Italian Alps), specifically selected due to its high sensitivity to climate warming and prone to ground instability phenomena.

7. Project Duration: (1 line maximum)

The duration of the project is two years.

8. Resources necessary for the Project and their mobilization

The joint research group collaborates with IMHE-CAS and DST-UNIFI. IMHE-CAS is the national research center for landslides monitoring and prevention in China, which counts 5 professors, 3 associate professors and 3 technicians in this proposed project. DST-UNIFI is one of the largest scientific and technological services centers on geohazard monitoring in Italy, currently composed by more than 50 full-time employees (2 full professors, 3 associate professor, 8 researchers, 9 technicians and several post-doc fellows and PhD students). The joint team has the necessary personnel, dedicated laboratory facilities, instrumentation and a well-established field support for carrying out effective research in the framework of the proposed project. The total budget of IMHE-CAS is related to international and national funding projects in 2020 is more than 400 Million USD. The required budget will be covered by IMHE-CAS for the research part. A contribution by ICL-IPL project budget might be required for dissemination purposes concerning the project results.

9. Project Description: (30 lines maximum)

Climate change is strongly affecting the global cryosphere and leads to an increase in activity of rock glaciers, creeping downslope and posing a potential threat in QTP (Qinghai-Tibet Plateau), Alps and Greenland due to warming temperatures and degrading permafrost. Understanding how these geohazards occur and their deformation process are highly significant to improve forecasting methods and taking precautions. Specifically, producing a regional-scale active rock glacier inventory map can help researchers and stakeholders to understand the displacement evolution of land terminating glaciers in different places. More importantly, the monitoring results can supplement the current dataset in Qinghai-Tibet where no rock glacier inventory has been conducted. A series of Sentinel-1 SAR images in ascending and descending orbits will be acquired and processed by a multi-interferometric (MT-InSAR) approach and Offset-tracking techniques. Time-series of ground deformation maps in different motion directions are generated by combining different geometries. For classifying

deformation patterns in Himalaya, Qinghai-Tibet and Italian Alps, auxiliary datasets and interpretation of long-term deformation trends are forced to be taken into consideration. Active, periodical active, inactive and fossil rock glaciers are expected to be recognized to construct the final rock glacier inventory mapping.

10. Work Plan/Expected Results: (20 lines maximum; work phases and milestones)

The project includes three Work phases (WP):

WP1- Multi-interferometric and offset-tracking analysis - which includes the processing of historical archive of Sentinel-1 and mapping elaborated deformation (Performed by IMHE-CAS).

WP2- Deformation interpretation and analysis - which includes the "radar-interpretation" activity, devoted to assign a geomorphological meaning to the point-wise ground displacements measurements and to obtain an accurate analysis of the phenomenon (Performed by DST-UNIFI and IMHE-CAS).

WP3- Identification of deformation pattern – which includes the deformation mechanism analysis, supported by auxiliary data superposing calculation (*i.e.*, meteorological, hydrological, geological and geomorphological maps, optical images (both aerial and satellite data). This part is carried out by IMHE-CAS and DST-UNIFI.

The project is expected to provide a direct contribution to the Kyoto Landslide Commitment 2020 (KLC2020) with special reference to the Action 3, related to the improvements of technologies for landside monitoring.

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

Information about the deformation velocity of active rock glaciers in China, Italy will be completed in 12-18 months. The final rock glacier inventory map (location, spatial distribution, time-series deformation pattern, type and future risk) will be transferred to local civil protection agencies and international landslides research councils (*e.g.*, ICL, ICIMOD, LEWS). Our monitoring result will be written in a report, and some interesting conclusions are intended to be submitted to the journal LANDSLIDES (*i.e.*, month 18-24 months) and to be presented to the Sixth World Landslide Forum (WLF6), that will be held in Florence in 2023.

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

The end-user of this project is local risk management entities of Qinghai-Tibet (China) and Region Authorities of Valle d'Aosta (Italian).

Enhancing academic communication between IMHE-CAS and DST-UNIFI. PhD students or researchers on both sides will visit and exchange under the support of this project. The detailed fee will be covered by other research projects or fundings.

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

Note: Please fill and submit this form **by 15 December 2021** to ICL Network

<icl-network@iclhq.org> and ICL secretariat <secretariat@iclhq.org>