

## **Application Form for World Centre of Excellence on Landslide Risk Reduction** **2020-2023**

1. **Name of Organization:** UNESCO Chair for the prevention and the sustainable management of geo-hydrological hazards, University of Firenze (UNIFI)

2. **Name of Leader:**

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Veronica Tofani, Department of Earth Sciences, University of Firenze

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3. **Date of Submission of Application:** 20/07/2019

4. **Activity scale and targeted region:** Global

5. **Short Title:** Advanced Technologies for LandSlides (ATLaS)

6. **Objectives for the initial 3 years:**

The objective is to develop new methodologies and advanced technologies for landslide risk reduction. UNIFI will carry out research and development (R&D) for the prevention and management of landslides, in order to support policies and actions of risk reduction. In particular, the project will focus on research activities concerning the landslide monitoring and early warning through innovative technologies, exploitation of EO (Earth Observation) data and technology to detect, map, monitor and forecast ground deformations, regional forecasting models and on activities related to education and training on landslides risk reduction.

7. **Background Justification:**

In 2015 the Sendai Partnership 2015/2025 was launched at the World Conference on Disaster Risk Reduction (WCDRR) in Sendai by the International Strategy for Disaster Reduction (ISDR) and by the International Consortium on Landslides (ICL), for global promotion of understanding and reducing landslide disaster risk. It was accepted and signed by 16 United Nations and international stakeholders, and National Organizations. UNIFI will sign during the Fifth World Landslide Forum (WLF5), in Kyoto November 2-6, 2020, the Kyoto

2020 Commitment for global promotion of understanding and reducing landslide disaster risk. The Kyoto 2020 Commitment is a further contribution to the Sendai Landslide Partnerships 2015-2025, the Sendai Framework for Disaster Risk Reduction 2015-2030, the 2030 Agenda Sustainable Development Goals, the New Urban Agenda and the Paris Climate Agreement.

UNIFI, in particular, will contribute to some priority actions of Kyoto 2020 Commitment which are Action 1, Action 2, Action 3, Action 6 and Action 9.

In this framework UNIFI wants to provide improvements concerning the methodologies and technologies for landslide risk reduction and population safety. In particular, landslide hazard and risk assessment will benefit from new and advanced technologies for landslide monitoring and early warning, from EO data for detection and mapping and regional forecasting models for landslides.

#### **8. Resources available for WCoE activities:**

The UNIFI staff counts: 5 professors and associate professors, 6 researchers, 11 technicians, 13 post-doc fellows, 12 PhD students.

The facilities of the research group include:

Laboratories:

- GIS and thematic mapping laboratory
- Remote Sensing laboratory specialized on SAR interferometry, optical and hyperspectral remote sensing
- Rock and Soil mechanics laboratory

Equipment:

- GBInSAR monitoring systems
- UAV (Unmanned Aerial Vehicle, SATURN)
- Compact submarine remotely controlled (NEMO-ROV)
- Rock and soil mechanics field and laboratory equipment
- Advanced geotechnical and hydrogeological modelling software
- GPS and topographical survey instrumentation
- 3D laser scanner
- Access to real-time meteorological services
- Fieldspec spectroradiometer
- Infrared thermal Camera and UAV sensor
- Robotized total stations
- Electrical resistivity, electromagnetic and seismic surveying instrumentation

- Portable laser scanner
- UAV Ground Penetrating Radar (GPR)

The group has an average yearly research budget of about 1.5 million Euro from research and development projects funded by national and international organizations.

Since its involvement in ICL, UNIFI has proposed several IPL projects such as:

IPL C103: Global landslide observation strategy (GLOS), Proposers: K. Takara and N. Casagli

IPL196: Development and applications of a multi-sensors drone for geohazards monitoring and mapping, Proposer: Veronica Tofani

IPL198: Multi-scale rainfall triggering models for Early Warning of Landslides (MUSE), Proposer: Filippo Catani

IPL 221: PS continuous streaming for landslide monitoring and mapping, Proposer: Federico Raspini and Silvia Bianchini

UNIFI has been involved as a partner in other projects propose by different ICL members, such as:

IPL C104: World Landslide Database (WLD), Proposer: Hiroshi Fukuoka

IPL 206: Towards improved landslide mapping and forecasting, Proposer: Fausto Guzzetti and Mario Parise

UNIFI has been already awarded as World Centre of Excellence (WCoE) for Landslide Risk Reduction for three times (2008-2010, 2011-2013, 2014-2016, 2017-2020).

## **9. Description of past activities related to risk reduction of landslides and other related earth system disasters**

Since 2004, the University of Firenze (UNIFI) is an official Centre of Competence of the Italian Civil Protection for Remote Sensing and Geohazards (Directive of the Italian Prime Minister of 27 February 2004; Decree of the Head of the Italian National Civil Protection Department no. 252 of 25 January 2005) and since 2018 has become a Civil Protection Centre. The Civil Protection Centre provides the following services: prediction and prevention of geo-hydrological risks, emergency response and recovery, planning and training activities, dissemination of knowledge and risk education, international relations and European Civil Protection Mechanism.

The Engineering geology group of the UNIFI group participates in research and technological development projects in several areas of the world, often in active collaboration with international, national and regional organizations and agencies. The main objective of the group is to focus on landslide studies at all scales with an emphasis that in recent years moved towards the application and development of new technologies for landslide disaster prevention, monitoring and early warning with special emphasis on remote sensing and regional landslide forecasting models. The work on these topics has produced hundreds of scientific

publications focusing on landslide studies ranging from slope to regional scale.

In June 2016, the UNIFI has successfully established an UNESCO Chair on Prevention and sustainable management of geo-hydrological hazards. The mission of the Chair is to promote research and development (R&D) for the prevention and management of geo-hydrological hazards, in order to support policies and actions of risk reduction. The main activities are connected to research and development, education and training, contribution to risk reduction policies, protection of cultural heritage, networking exchanges.

In December 2018 during the ICL-IPL Conference, held in Kyoto on 1-4 December 2018, the ICL Italian network has been officially established. ICL Italian network, proposed and coordinated by the UNIFI, currently counts 14 ICL members (7 Full members, 6 Associates and 1 Supporter). The general objective of the Italian ICL Network is to contribute at national level to the Sendai Partnership for Disaster Risk Reduction 2015-2025 for the national promotion of understanding, prevention and sustainable management of landslide risk disaster, for the safety of human life, society and the environment.

The recent research achievements of UNIFI mainly concerned the: i) ground-based SAR interferometry for landslide monitoring and development of reliable procedures and technologies for early warning; ii) EO (Earth Observation) data and technology to detect, map, monitor and forecast ground deformations; iii) Coupling of short-term weather forecasting with geotechnical modelling for shallow landslide prediction. The main current international research projects of UNIFI are: i) HORIZON 2020 UGeohaz- (Geohazard impact assessment for urban areas) focused on monitoring geohazard-associated ground deformations, a key prevention action that is specifically addressed to urban areas and critical infrastructures. The project proposes a procedure to produce maps to continuously assess the potential impact of geohazard activity; ii) HORIZON 2020 SARA (Search And Rescue Aid And Surveillance Using High EGNSS Accuracy) with the purpose to engineer and start to commercialize a dedicated solution, based on an already existing prototype, to be used for Search and Rescue (SaR) and Surveillance purposes.

#### 10. **Planned future activities /Expected Results:**

The activities proposed are structured into 4 main work phases (WPs) as follows:

**WP1-Monitoring unstable slopes and integration of different techniques for the set-up of early warning systems:** Application of advanced technologies and methodologies for the management of geo-hydrological disasters. This activity focuses on the application of innovative monitoring techniques and the operative implementation of Early Warning Systems (EWS). This is achieved by the synergistic use of rapid mobile units for localized survey based on terrestrial, marine and airborne sensors.

**WP2-EO data for for mapping, characterization and monitoring of landslides:** Application of high resolution EO data for the ground deformation mapping and monitoring with millimetric precision, from local

to regional scale. The final aim is the satellite surveillance system based on all the Earth Observation data (radar, multi- and hyperspectral) available from several constellation of satellites.

**WP3-Landslide risk assessment and regional landslide forecasting models:** Evaluation of landslide risk at regional and national scale and with special emphasis on the evaluation of expected damages related to landslides. Implementation and validation of regional landslide forecasting models both statistical and physically-based.

**WP4-Education and training activities on landslides risk reduction:** Fostering education and training on geo-hydrological hazards aimed at promoting knowledge and capacity building. The UNIFI, in collaboration with the UNESCO Chair, will organize seminars, conferences aimed at promoting a network of knowledge sharing and providing advanced training for hydrogeological risk management.

The project foresees three main milestones:

**Milestone 1:** Publication of the research activities carried out as WCoE in Landslides journal

**Milestone 2:** Submission of new IPL projects, also in collaboration with other ICL members and associates

**Milestone 3:** Contribution to the Kyoto commitment through the above-mentioned research activities and contribution to the further publication of Landslide landslide interactive teaching tools.

#### 11. **Beneficiaries of WCoE:**

The beneficiaries of the present project will be National and Regional Civil Protection Agencies and National and Regional Environmental Protection Agencies, the ICL community, the United Nations organizations and Local communities interested in the practical applications of landslide risk reduction measures. We expect to cooperate with other ICL members to strengthen the networking activities.

#### 12. **References:**

Carlà T, Tofani V., Lombardi L., Raspini F, Bianchini S, Bertolo D, Thuegaz P, Casagli N (2019)

Combination of GNSS, satellite InSAR, and GBInSAR remote sensing monitoring to improve the understanding of a large landslide in high alpine environment, GEOMORPHOLOGY, Volume 335, 15 June 2019, Pages 62-75

Casagli N; Frodella W; Morelli S; Tofani V; Ciampalini A; Intrieri E; Raspini F; Rossi G; Tanteri L; Lu P (2017) Spaceborne, UAV and ground-based remote sensing techniques for landslide mapping, monitoring and early warning, GEOENVIRONMENTAL DISASTERS, 4(9), 1, 23

Di Traglia F; Nolesini T; Ciampalini A; Solari L; Frodella W; Bellotti F; Fumagalli A; De Rosa G; Casagli N (2018) Tracking morphological changes and slope instability using spaceborne and ground-based SAR data, GEOMORPHOLOGY, 300, 95, 112

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Rosi A.; Tofani V.; Tanteri L.; Tacconi Stefanelli C.; Agostini A.; Catani F.; Casagli N. (2018) The new landslide inventory of Tuscany (Italy) updated with PS-InSAR: geomorphological features and landslide distribution, LANDSLIDES, 15(1), 5, 19

Salvatici T; Tofani V; Rossi G; D'Ambrosio M; Tacconi Stefanelli C; Masi EB; Rosi A; Pazzi V; Vannocci P; Petrolo M; Catani F; Ratto S; Stevenin H; Casagli N (2018) Application of a physically based model to forecast shallow landslides at a regional scale, NATURAL HAZARDS AND EARTH SYSTEM SCIENCES, 18(7), 1919, 1935

Segoni S; Tofani V; Rosi A; Catani F; Casagli N (2018) Combination of rainfall thresholds and susceptibility maps for dynamic landslide hazard assessment at regional scale, FRONTIERS IN EARTH SCIENCE, 6, 1, 11

Tofani V; Bicocchi G; Rossi G; Segoni S; D'Ambrosio M; Casagli N; Catani F (2017) Soil characterization for shallow landslides modeling: a case study in the Northern Apennines (Central Italy), LANDSLIDES, 14, 755, 770

**13. If your organization is an ongoing WCoE 2014-2017, please attach the articles reporting activities of WCoE, IPL project and ICL network published/contributed to either in *Landslides: Journal of International Consortium on Landslides* or/and the Fourth World Landslide Forum 2017.**

The publication are listed below and attached.

Activities of WCoE:

Casagli N.; Tofani V. (2019) Department of Earth Sciences, University of Florence. Landslides, in press.

Carlà T.; Nolesini T.; Solari L.; Rivolta C.; Dei Cas L.; Casagli N. (2019) Rockfall forecasting and risk management along a major transportation corridor in the Alps through ground-based radar interferometry. Landslide, Springer, 1-11 pp, online first

Del Soldato M; Riquelme A; Bianchini S; Tomàs R; Di Martire D; De Vita P, Moretti S; Calcaterra D, (2018) Multisource data integration to investigate one century of evolution for the Agnone landslide (Molise, southern Italy), Landslides, Springer. 1, 16

Frodella W; Ciampalini A; Bardi F; Salvatici T; Di Traglia F; Basile G; Casagli N. (2018) A method for assessing and managing landslide residual hazard in urban areas, Landslides, Springer, 15(2), 183, 197

- Intrieri E; Raspini F; Fumagalli A; Lu P; Del Conte S; Farina P; Allievi J; Ferretti A; Casagli N (2018) The Maoxian landslide as seen from space: detecting precursors of failure with Sentinel-1 data, *Landslides*, Springer, 15(1), 123, 133
- Rosi A.; Tofani V.; Tanteri L.; Tacconi Stefanelli C.; Agostini A.; Catani F.; Casagli N. (2018) The new landslide inventory of Tuscany (Italy) updated with PS-InSAR: geomorphological features and landslide distribution, *Landslides*, Springer, 15(1), 5, 19
- Solari L.; Raspini F.; Del Soldato M.; Bianchini S.; Ciampalini A.; Ferrigno F.; Tucci S.; Casagli N. (2018) Satellite radar data for back-analyzing a landslide event: the Ponzano (Central Italy) case study. *Landslides*, Springer, 15(4), 773, 782
- Tacconi Stefanelli C.; Vilímek V.; Emmer A.; Catani F. (2018) Morphological analysis and features of the landslide dams in the Cordillera Blanca, Peru, *Landslides*, Springer, 15(3), 507, 521
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- Casagli N.; Tofani V.; Morelli S.; Frodella W.; Ciampalini A.; Raspini F.; Intrieri E. (2017) Remote sensing techniques in landslide mapping and monitoring, keynote lecture. *Advancing culture of living with landslides - Volume 3: Advances in landslide technology*, 1, 19, Springer, Cham
- Nolesini T.; Frodella W.; Lombardi L.; Nocentini M.; Bardi F.; Intrieri E.; Carlà T.; Solari L.; Dotta G.; Ferrigno F.; Casagli N. (2017) Remote 3D mapping and GB-InSAR monitoring of the Calatabiano landslide (Southern Italy). *Advancing culture of living with landslides - Volume 3: Advances in landslide technology*, 277, 284, Springer, Cham
- Pazzi V.; Tanteri L.; Bicocchi G.; Caselli A.; D'Ambrosio M.; Fanti R. (2017) H/V Technique for the rapid detection of landslide slip surface(s): assessment of the optimized measurements spatial distribution. *Advancing culture of living with landslides - Volume 2: Advances in landslide science*, 335, 343, Springer, Cham
- Morelli S.; Pazzi V.; Monroy V. H. G.; Casagli N. (2017) Residual slope stability in low order streams of anganguero mining area (Michoacán, Mexico) after the 2010 debris flows. *Advancing culture of living with landslides - Volume 4: Diversity of landslide forms*, 651, 660, Springer, Cham
- Margottini C.; Spizzichino D.; Gigli G.; Ruther H.; Casagli N. (2017) True 3D kinematic analysis for slope instability assessment in the Siq of Petra (Jordan), from high resolution TLS. *Advancing culture of living with landslides - Volume 4: Diversity of landslide forms*, 527, 535, Springer, Cham

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Casagli N.; Tofani V.; Catani F.; Moretti S.; Fanti R.; Gigli G. (2017) Advanced technologies for landslides (WCoE 2014–2017, IPL-196, IPL-198). *Advancing culture of living with landslides - Volume 1: ISDR-ICL Sendai Partnerships 2015–2025*, 269, 277, Springer, Cham

Bianchini S.; Nolesini T.; Del Soldato M.; Casagli N. (2017) Evaluation of building damages induced by landslides in Volterra area (Italy) through remote sensing techniques. *Advancing culture of living with landslides - Volume 5: Landslides in different environments*, 111, 120, Springer, Cham

Ciampalini A.; Raspini F.; Lagomarsino D.; Catani F.; Casagli N. (2017) How to improve the accuracy of landslide susceptibility maps using PSInSAR data. *Advancing culture of living with landslides - Volume 2: Advances in landslide science*, 965, 971, Springer, Cham

Bardi F.; Raspini F.; Frodella W.; Lombardi L.; Nocentini M.; Gigli G.; Morelli S.; Corsini A.; Casagli N. (2017) Remote sensing mapping and monitoring of the Capriglio landslide (Parma Province, Northern Italy). *Advancing culture of living with landslides - Volume 3: Advances in landslide technology*, 231, 238, Springer, Cham

Carlà T.; Intrieri E.; Farina P.; Casagli N. (2017) A new approach to assess the stability of rock slopes and identify impending failure conditions. *Advancing culture of living with landslides - Volume 2: Advances in landslide science*, 733, 739, Springer, Cham

Raspini F.; Ciampalini A.; Del Conte S.; Lombardi L.; Nocentini M.; Gigli G.; Ferretti A.; Casagli N. (2017) Mapping rapid-moving landslide with satellite SAR images: the case of Montescaglioso (South Italy). *Advancing culture of living with landslides - Volume 2: Advances in landslide science*, 171, 177, Springer, Cham

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Rosi A.; Segoni S.; Battistini A.; Rossi G.; Catani F.; Casagli N. (2017) Definition of a fully functional EWS based on rainfall thresholds, the case of study of Tuscany region. *Advancing culture of living with landslides - Volume 3: Advances in landslide technology*, 169, 174, Springer, Cham



Taconi Stefanelli C.; Segoni S.; Casagli N.; Catani F. (2017) Assessing landslide dams evolution: a methodology review. *Advancing culture of living with landslides - Volume 5: Landslides in different environments*, 253, 257, Springer, Cham

Di Traglia F.; Nolesini T.; Casagli N. (2017) Monitoring eruption-induced mass-wasting at active volcanoes: the Stromboli case. *Advancing culture of living with landslides - Volume 4: Diversity of landslide forms*, 669, 676, Springer, Cham

Lombardi L.; Nocentini M.; Frodella W.; Nolesini T.; Bardi F.; Intrieri E.; Carlà T.; Solari L.; Dotta G.; Ferrigno F.; Casagli N. (2017) The Calatabiano landslide (southern Italy): preliminary GB-InSAR monitoring data and remote 3D mapping, *Landslides*, Springer, 14(2), 685, 696

#### IPL Projects:

Raspini F.; Bianchini S.; Ciampalini A.; Del Soldato M.; Montalti R.; Solari L.; Tofani V.; Casagli C. (in press) Permanent Scatterers continuous streaming for landslide monitoring and mapping: the case of Tuscany Region (Italy), *Landslides*, Springer

Rossi G.; Tanteri L.; Tofani V.; Vannocci P.; Moretti S.; Casagli N. (2018) Multitemporal UAV surveys for landslide mapping and characterization, *Landslides*, Springer, 15(5), 1045, 1052

Tanteri L.; Rossi G.; Tofani V.; Vannocci P.; Moretti S.; Casagli N. (2017) Multitemporal UAV survey for mass movement detection and monitoring. *Advancing culture of living with landslides - Volume 2: Advances in landslide science*, 153, 161, Springer, Cham

Tofani V.; Bicocchi G.; Rossi G.; Segoni S.; D'Ambrosio M.; Casagli N.; Catani F. (2017) Soil characterization for shallow landslides modeling: a case study in the Northern Apennines (Central Italy), *Landslides*, Springer, 14, 755, 770

Tofani V.; Bicocchi G.; Rossi G.; D'Ambrosio M.; Catani F.; Casagli N. (2017) Soil characterization for landslide forecasting models: a case study in the Northern Apennines (Central Italy), *Advancing culture of living with landslides - Volume 2: Advances in landslide science*, 381, 388, Springer, Cham

#### ICL Italian network:

Casagli N, Tofani V (2018) Establishment of ICL Italian network. *Landslides* 15 (10).

#### **14. List of published or planned reports of WCOE 2017-2020 in journal “Landslides” or “WLF5 books” for ongoing WCOE organization.**

##### Published:

Casagli N, Tofani V (2019) Department of Earth Sciences, University of Florence. *Landslides*, in press.

Planned:

Report on WCOE 2017-2020 “Advanced Technologies for LandSlides (ATLaS)” in WLF5 book

Report of WCoE 2017-2020 to be submitted in Landslides journal in 2020