Application Form for World Centre of Excellence on Landslide Risk Reduction

2023-2026

1. **Name of Organization**: UNESCO Chair on Prevention and Sustainable Management of Geo-Hydrological Hazards, University of Florence (from here on: "UNESCO Chair").
2. **Name of Leader**:

   Nicola Casagli

   Full Professor

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   Core members of the activities:

   Veronica Tofani (Associate Professor), Department of Earth Sciences- UNESCO Chair on Prevention and Sustainable Management of Geo-Hydrological Hazards, University of Florence

   Sandro Moretti (Full Professor), Department of Earth Sciences- UNESCO Chair on Prevention and Sustainable Management of Geo-Hydrological Hazards, University of Florence

   Giovanni Gigli (Associate Professor), Department of Earth Sciences- UNESCO Chair on Prevention and Sustainable Management of Geo-Hydrological Hazards, University of Florence

   Riccardo Fanti (Associate Professor), Department of Earth Sciences- UNESCO Chair on Prevention and Sustainable Management of Geo-Hydrological Hazards, University of Florence

   William Frodella (Technologist), Department of Earth Sciences-UNESCO Chair on Prevention and Sustainable Management of Geo-Hydrological Hazards, University of Florence

   Fabio Castelli (Full Professor), Department of Civil and Environmental Engineering-UNESCO Chair on Prevention and Sustainable Management of Geo-Hydrological Hazards, University of Florence

   Claudio Margottini (Adjunt Professor), UNESCO Chair on Prevention and Sustainable Management of Geo-Hydrological Hazards, University of Florence
3. **Date of Submission of Application**: 30/03/2023
4. **Activity scale and targeted region:** Global
5. **Short Title characterizing past and planned activities**: Advanced Technologies for LandSlides (ATLaS)

6. **Objectives for 3 years**:

The UNESCO CHAIR will carry out research and development on advanced technologies and new methodologies for the prevention and management of landslide risk to support policies and actions of risk reduction. In detail, the project will focus on landslide monitoring and early warning using innovative technologies, Earth Observation data, and regional forecasting models to detect, map, monitor and forecast ground deformations as well as the development of regional and national quantitative landslide risk assessment procedures. A key action of the project will also be the education, training, and capacity building on landslides risk reduction for resilience enhancement.

7. **Background Justification**:

The UNESCO Chair on Prevention and sustainable management of geo-hydrological hazards was established in June 2016 at the University of Florence from the initiative of two different departments: the Department of Earth Sciences (DST) and the Department of Civil and Environmental Engineering (DICEA). The Chair, renewed for the period 2020-2024, represents the first chair in Italy dedicated to applied research in the field of Geo-Hydrological hazards threatening human life, property, cultural heritage, the natural and built environment. The Chair mission is to promote Research and Development (R&D) for the prevention and management of geo-hydrological hazards, to support policies and actions of risk reduction. The specific objectives are:

- to promote the development of innovative technologies for the prevention and mitigation of geo-hydrological hazards
- to develop tools and procedures for supporting risk reduction policies and the management of emergencies for the safety of human life
- to promote the protection of cultural heritage threatened by geo-hydrological hazards
- to promote research at the international level by offering scientific facilities to postgraduate students and visiting researchers

The UNESCO CHAIR is signatory of the Kyoto Landslide Commitment 2020 (KLC 2020) for global promotion of understanding and reducing landslide disaster risk. The KLC 2020 is promoted by the ICL as a contribution to the Sendai Partnerships 2015-2025, the Sendai Framework for Disaster Risk Reduction 2015-2030, the 2030 Agenda for Sustainable Development Goals, the New Urban Agenda, and the Paris Climate Agreement. The UNESCO Chair is organizing the 6th World Landslide Forum (WLF6) in Florence from 14 to 17 November 2023. The UNESCO Chair, formerly as Department of Earth Sciences of the University of Florence, has been awarded by the ICL as World Centre of Excellence (WCoE) for Landslide Risk Reduction for five consecutive times in the following triennia: 2008-2010, 2011-2013, 2014-2016, 2017-2020, 2020-2023.

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

The UNESCO CHAIR staff counts 22 between full, associate, and adjunct professors, 11 researchers, 10 technicians, 3 post-doc fellows, 14 PhD students.

The facilities of the research group include:

Laboratories

- GIS and thematic mapping laboratory
- Remote Sensing laboratory specialized on SAR interferometry, optical multi- and hyperspectral remote sensing
- Rock and Soil mechanics laboratory
- Stone materials and engineering, environmental and landscape geology

Equipment

- GBInSAR portable monitoring systems
- Compact submarine remotely controlled (NEMO-ROV)
- Rock and soil mechanics field and laboratory equipment
- Advanced geotechnical and hydrogeological modelling software
- Advanced photogrammetric modelling software
- GPS and topographical survey instrumentation
- Access to real-time meteorological services
- Fieldspec spectroradiometer
- Infrared thermal camera
- Robotized total station
- Electrical resistivity, electromagnetic and seismic surveying instrumentation
- 3D laser scanner
- Ground Penetrating Radar (GPR)
- Wireless sensor networks
- UAV (Uncrewed Aerial Vehicle), SATURN and SATURN mini
- UAV Near Infrared camera
- UAV High resolution digital camera
- UAV laser scanner
- UAV Infrared Thermal sensor
- UAV Ground Penetrating Radar (GPR)
- 3D printers

The group has an average yearly research budget of about 5.5 million Euros from research and development projects funded by national and international organizations.

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

The UNESCO CHAIR 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, funded by national and international organizations in the field of prevention and management of geo-hydrological hazards with special emphasis to landslides and subsidence. In this framework since its involvement in ICL, the UNESCO CHAIR has proposed several IPL projects. Currently the active projects are:

IPL project 221: PS continuous streaming for landslide monitoring and mapping. Proposers: Federico Raspini and Silvia Bianchini.

IPL-255: Monitoring rock glaciers kinematic process using SAR interferometry and offset-tracking in Alpine environment. Proposers: Quingkai Meng and Federico Raspini.

IPL-258: Slope stability in vineyards with different management practices (Acronym: WINESLIDES). Proposer: Filippo Catani.

IPL-259: Landslide Risk assessment in AlUla Archaeological sites. Proposer: Claudio Margottini.

IPL-260: Landslide Risk assessment in the High City of Antananarivo. Proposer: William Frodella.

Furthermore, the main current international research projects of the UNESCO CHAIR are:

EU-funded projects:

- LINKS (Strengthening Links between Technologies and Society for European Disaster Resilience; a Horizon 2020 project; http://links-project.eu)
- PassPORT-Operational Platform managing a fleet of semi-autonomous drones exploiting GNSS high Accuracy and Authentication to improve Security & Safety in port areas; https://www.euspa.europa.eu/operational-platform-managing-fleet-semi-autonomous-drones-exploiting-gnss-high-accuracy-and)
- ROMERO (Robots for Extreme Environments; https://www.romero-esmera.it/), a ESMERA (Boosting Robotics Innovation) European Consortium-funded project
- EUSATfinder, a European SME Robotics Application-funded project.
- EGMS RASTOOL (European ground motion risk assessment tool), an ECHO EU-funded project.
- Copernicus European Ground Motion (EU-GMS; https://land.copernicus.eu/pan-european/european-ground-motion-service), funded by the European Environment Agency (EEA).

Erasmus+:

- Re-HeED - Reframing Heritage Education in Egypt. Erasmus+ KA2 Cooperation for innovation and the exchange of good practices.
- Erasmus + KA 107 - Scientific-cultural collaboration with Ilia State University (Georgia).

European Space Agency (ESA)-funded projects:

- PATHFINDER (PNT as A TecHnology to support drones' BVLOS scenarios for preventive monitoring and FIrst respoNDER missions)
- G-Class Hydroterra (an Earth Explorer mission for Water Cycle Science).

Other international relevant projects:

- Strengthening Financial Resilience and Accelerating Risk Reduction in Central Asia (SFRARR) - Regionally consistent risk assessment for earthquakes and floods and selective landslide scenario analysis for strengthening financial resilience and accelerating risk reduction in Central Asia. Leaders of Task 7 "Landslide Scenario Assessment" (2020-present). Funded by the World Bank.

The UNESCO Chair is involved together with the Civil Protection Center of the University of Florence in several emergency operational activities for the technical support in the geo-hydrological hazards treating human life and infrastructures.

The UNESCO Chair participates in several national and international missions, in collaboration with UNESCO and official partners, to promote the protection of the World's cultural heritage threatened by geo-hydrological hazards, some of which part of the UNESCO World Heritage list, especially in developing countries.

The UNESCO Chair is organizing the 6th World Landslides Forum (WLF6), which will be held in Florence, Italy from November 14-17, 2023. The WLF6 is entitled as "Landslide Science for sustainable development" and is a contribution to the KLC 2020 for the global promotion of understanding and reducing landslide disaster risk. The forum will cover the main aspects related to the analysis and monitoring of landslide phenomena: from early warning to modeling, from hazard and risk assessment to mitigation techniques, and to triggering mechanisms and climate change. WLF6 is organized according to the following scientific themes:

- Theme 1: Kyoto commitment to landslides and sustainable development
- Theme 2: Remote sensing, monitoring and early warning
- Theme 3: Testing, modeling, and mitigation techniques
- Theme 4: Mapping, risk, risk assessment and management
- Theme 5: Climate change, extreme weather phenomena, earthquakes, and landslides
- Theme 6: Advances in landslide science and applications.

10. **Planned future activities/Expected Results**: (20 lines maximum; work phases and milestones)

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 mapping, characterization, and monitoring of geo-hydrological hazards: 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 (cutting edge radar, multi- and hyperspectral sensors) available from the available satellite constellations.

WP3-Landslide risk assessment and regional forecasting models: evaluation of landslide risk at a national regional and regional scale, with special focus on the evaluation of the potential landslide-induced damage. Implementation and validation of statistical and physically based landslide forecasting models at a basin and regional scale.

WP4-Education and landslide resilience: fostering education and training on geo-hydrological hazards aimed at resilience enhancement and capacity building. The UNESCO Chair will organize seminars, webinars, conferences, workshops, field experiences and project activities, aimed at promoting a network of knowledge sharing and providing advanced training for the comprehension and management of geo-hydrological risks.

The project foresees three main milestones:

Milestone 1: Publication of the research activities carried out carried in the framework of WCoE and IPL projects in the Landslides Journal and on the ICL Open Access Book series “Progress in landslide science and technology”.

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

Milestone 3: Support to the organization of the 7th World Landslide Forum (WLF7) and promotion of the ICL activities.

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, international organizations and local communities involved in the practical applications of landslide risk reduction measures. we expect to cooperate with other ICL members to enhance the cooperation in the field of sustainable landslide risk reduction strategies.

12. **References**: 10 lines maximum, e.g., relevant publications, international/regional/national recognition supporting items 9-10.

- Solari, L., Bianchini, S., Franceschini, R., Barra, A., Monserrat, O., Thuegaz, P., Catani, F. (2020). Satellite interferometric data for landslide intensity evaluation in mountainous regions. International Journal of Applied Earth Observation and Geoinformation, 87, 102028.
- Frodella, W., Elashvili, M., Spizzichino, D., Gigli, G., Nadaraia, A., Kirkitadze, G., Casagli, N. (2021). Applying Close Range Non-Destructive Techniques for the Detection of Conservation Problems in Rock-Carved Cultural Heritage Sites. Remote Sensing, 13(5), 1040.
- Rosi, A., Segoni, S., Canavesi, V., Monni, A., Gallucci, A., Casagli, N. (2021). Definition of 3D rainfall thresholds to increase operative landslide early warning system performances. Landslides, 18(3), 1045-1057.
- Carla, T., Gigli, G., Lombardi, L., Nocentini, M., Casagli, N. (2021). Monitoring and analysis of the exceptional displacements affecting debris at the top of a highly disaggregated rockslide. Engineering Geology, 294, 106345.
- Confuorto, P., Del Soldato, M., Solari, L., Festa, D., Bianchini, S., Raspini, F., Casagli, N. (2021). Sentinel-1-based monitoring services at regional scale in Italy: State of the art and main findings. International Journal of Applied Earth Observation and Geoinformation, 102, 102448.
- Caleca, F., Tofani, V., Segoni, S., Raspini, F., Rosi, A., Natali, M., Casagli, N. (2022). A methodological approach of QRA for slow-moving landslides at a regional scale. Landslides, 1-23.
- Gigli, G., Lombardi, L., Carla, T., Beni, T., Casagli, N. (2022). A method for full three-dimensional kinematic analysis of steep rock walls based on high-resolution point cloud data. International Journal of Rock Mechanics and Mining Sciences, 157, 105178.
- Masi, E. B., Tofani, V., Rossi, G., Cuomo, S., Wu, W., Salciarini, D., Catani, F. (2023). Effects of roots cohesion on regional distributed slope stability modelling. Catena, 222, 106853.
- Casagli, N., Intrieri, E., Tofani, V., Giovanni Gigli, Federico Raspini (2023) Landslide detection, monitoring and prediction with remote-sensing techniques. Nat Rev Earth Environ 4, 51–64.

13. **If your organization is an ongoing WCoE 2020-2023, please attach the articles as pdf files reporting activities of WCoE, IPL project and ICL network published/contributed or a list of planned reports of WCOE 2020-2023 to either journal "Landslides" or/and "P-LRT books."**

    List of attached publication:

    Landslides journal

    1. Di Traglia, F., Calvari, S., Borselli, L. et al. Assessing flank instability of Stromboli volcano (Italy) by

reappraising the 30 December 2002 tsunamigenic landslides. Landslides (2023). https://doi.org/10.1007/s10346-023-02043-5

2. Casagli, N., Canuti, P., Sassa, K. et al. The sixth world landslide forum (WLF6): call for abstracts. Landslides 20, 707–716 (2023). https://doi.org/10.1007/s10346-022-02017-z
3. Casagli, N. Invitation to the 6th World Landslide Forum (WLF6). Landslides 20, 717 (2023). https://doi.org/10.1007/s10346-023-02041-7
4. Confuorto, P., Casagli, N., Casu, F. et al. Sentinel-1 P-SBAS data for the update of the state of activity of national landslide inventory maps. Landslides (2023). https://doi.org/10.1007/s10346-022-02024-0
5. Innocenti, A., Pazzi, V., Borselli, L., Nocentini, M., Lombardi, L., Gigli, G., Fanti, R. (2023). Reconstruction of the evolution phases of a landslide by using multi-layer back-analysis methods. Landslides, 20(1), 189-207. https://doi.org/10.1007/s10346-022-01971-y
6. Frodella, W., Rosi, A., Spizzichino, D. et al. Integrated approach for landslide hazard assessment in the High City of Antananarivo, Madagascar (UNESCO tentative site). Landslides 19, 2685–2709 (2022). https://doi.org/10.1007/s10346-022-01933-4
7. Casagli, N., Canuti, P., Sassa, K. et al. The Sixth World Landslide Forum (WLF6) on November 14–17, 2023, Florence, Italy. Landslides 19, 2539–2545 (2022). https://doi.org/10.1007/s10346-022-01941-4
8. Liang, X., Segoni, S., Yin, K. et al. Characteristics of landslides and debris flows triggered by extreme rainfall in Daoshi Town during the 2019 Typhoon Lekima, Zhejiang Province, China. Landslides 19, 1735–1749 (2022). https://doi.org/10.1007/s10346-022-01889-5
9. Caleca, F., Tofani, V., Segoni, S., Raspini, F., Rosi, A., Natali, M., Casagli, N. (2022). A methodological approach of QRA for slow-moving landslides at a regional scale. Landslides, 19, 1539–1561 (2022). https://doi.org/10.1007/s10346-022-01875-x
10. Franceschini, R., Rosi, A., Catani, F. et al. Exploring a landslide inventory created by automated web data mining: the case of Italy. Landslides 19, 841–853 (2022). https://doi.org/10.1007/s10346-021-01799-y
11. Casagli, N. Foreword by Nicola Casagli. Landslides 18, 3–4 (2021). https://doi.org/10.1007/s10346-020-01577-2
12. Intrieri, E., Meng, Q., Tofani, V. (2021). KLC2020 implementation: challenges for the development of satellite landslide early warning systems. Landslides, Landslides 18, 3499–3502 (2021). https://doi.org/10.1007/s10346-021-01721-6
13. Song, C., Yu, C., Li, Z., Pazzi, V., Del Soldato, M., Cruz, A., Utili, S. (2021). Landslide geometry and

activity in Villa de la Independencia (Bolivia) revealed by InSAR and seismic noise measurements. Landslides, Landslides 18, 2721–2737 (2021). https://doi.org/10.1007/s10346-021-01659-9

14. Rosi, A., Segoni, S., Canavesi, V. et al. Definition of 3D rainfall thresholds to increase operative landslide early warning system performances. Landslides 18, 1045–1057 (2021). https://doi.org/10.1007/s10346-020-01523-2
15. Meng, Q., Li, W., Raspini, F., Xu, Q., Peng, Y., Ju, Y., Casagli, N. (2020). Time-series analysis of the evolution of large-scale loess landslides using InSAR and UAV photogrammetry techniques: a case study in Hongheyan, Gansu Province, Northwest China. Landslides, 18, 251–265 (2021). https://doi.org/10.1007/s10346-020-01490-8
16. Doglioni, A., Casagli, N., Nocentini, M., Sdao, F., Simeone, V. (2020). The landslide of Pomarico, South Italy, occurred on January 29th, 2019. Landslides, 17, 2137–2143 (2020). https://doi.org/10.1007/s10346-
17. Feng, L., Intrieri, E., Pazzi, V., Gigli, G., Tucci, G. (2020). A framework for temporal and spatial rockfall early warning using micro-seismic monitoring. Landslides, 18, 1059–1070 (2021). https://doi.org/10.1007/s10346-020-01534-z
18. Cuomo, S., Masi, E. B., Tofani, V., Moscariello, M., Rossi, G., Matano, F. (2020). Multiseasonal probabilistic slope stability analysis of a large area of unsaturated pyroclastic soils. Landslides, 18, 1259–1274 (2021). https://doi.org/10.1007/s10346-020-01561-w
19. Stefanelli, C. T., Casagli, N., Catani, F. (2020). Landslide damming hazard susceptibility maps: a new GIS-based procedure for risk management. Landslides, 17, 1635–1648 (2020). https://doi.org/10.1007/s10346-020-01395-6
20. Kim, S. W., Chun, K. W., Kim, M., Catani, F., Choi, B., Seo, J. I. (2020). Effect of antecedent rainfall conditions and their variations on shallow landslide-triggering rainfall thresholds in South Korea. Landslides, 18, 569–582 (2021). https://doi.org/10.1007/s10346-020-01505-4
21. Catani, F. (2020). Landslide detection by deep learning of non-nadiral and crowdsourced optical images. Landslides, 18, 1025–1044 (2021). https://doi.org/10.1007/s10346-020-01513-4
22. Segoni, S., Pappafico, G., Luti, T., Catani, F. (2020). Landslide susceptibility assessment in complex geological settings: Sensitivity to geological information and insights on its parameterization. Landslides, 17, 2443–2453 (2020). https://doi.org/10.1007/s10346-019-01340-2
23. Xiao, T., Segoni, S., Chen, L., Yin, K., Casagli, N. (2020). A step beyond landslide susceptibility maps: A simple method to investigate and explain the different outcomes obtained by different approaches. Landslides, 17, 627–640 (2020). https://doi.org/10.1007/s10346-019-01299-0

P-LRT books

1. Casagli, N. et al. (2023). Advanced Technologies for Landslides—ATLaS (WCoE 2020–2023). In: Sassa, K., Konagai, K., Tiwari, B., Arbanas, Ž., Sassa, S. (eds) Progress in Landslide Research and Technology, Volume 1 Issue 1, 2022. Progress in Landslide Research and Technology. Springer, Cham. https://doi.org/10.1007/978-3-031-16898-7_19

WLF5 books:

1. Casagli, N., Intrieri, E., Carlà, T., Di Traglia, F., Frodella, W., Gigli, G., Tofani, V. (2020). Monitoring and Early Warning Systems: Applications and Perspectives. In Workshop on World Landslide Forum (pp. 1-21). Springer, Cham.
2. Morelli, S., Pazzi, V., Tofani, V., Raspini, F., Bianchini, S., Casagli, N. (2020). Reconstruction of the Slope Instability Conditions Before the 2016 Failure in an Urbanized District of Florence (Italy), a UNESCO World Heritage Site. In Workshop on World Landslide Forum (pp. 449-455). Springer, Cham.
3. Stefanelli, C. T., Casagli, N., Catani, F. (2020). Damming Predisposition of River Networks: A Mapping Methodology. In Workshop on World Landslide Forum (pp. 127-132). Springer, Cham.
4. Intrieri, E., Dotta, G., Raspini, F., Rosi, A., Segoni, S., Casagli, N. (2020). Early Warning Systems in Italy: State-of-the-Art and Future Trends. In Workshop on World Landslide Forum (pp. 537-543). Springer, Cham.
5. Di Traglia, F., Nolesini, T., Casagli, N. (2020). Dealing with Mass Flow-Induced Tsunamis at Stromboli Volcano: Monitoring Strategies Through Multi-Platform Remote Sensing. In Workshop on World Landslide Forum (pp. 397-404). Springer, Cham.
6. Raspini, F., Intrieri, E., Festa, D., Casagli, N. (2020). Landslide Mapping and Monitoring with Satellite Interferometry. In Workshop on World Landslide Forum (pp. 149-154). Springer, Cham.
7. Frodella, W., Spizzichino, D., Ciampalini, A., Ascanio, R., Margottini, C., Casagli, N. (2020). Shallow Landslide Susceptibility Assessment in the High City of Antananarivo (Madagascar). In Workshop on World Landslide Forum (pp. 465-470). Springer, Cham.
8. Solari, L., Festa, D., Confuorto, P., Bianchini, S., Casagli, N. (2020). From Satellite Images to Field Survey: A Complete Scheme of Landslide InSAR Monitoring. In Workshop on World Landslide Forum (pp. 411-418). Springer, Cham.
9. Frodella, W., Spizzichino, D., Gigli, G., Elashvili, M., Margottini, C., Villa, A., Casagli, N. (2020). Integrating Kinematic Analysis and Infrared Thermography for Instability Processes Assessment in the Rupestrian Monastery Complex of David Gareja (Georgia). In Workshop on World Landslide Forum

(pp. 457-463). Springer, Cham.

10. Stefanelli, C. T., Gracchi, T., Rossi, G., Moretti, S. (2020). Large and Small Scale Multi-Sensors Remote Sensing for Landslide Characterisation and Monitoring. In Workshop on World Landslide Forum (pp. 349-359). Springer, Cham.
11. Tofani, V., Bicocchi, G., Masi, E. B., Stefanelli, C. T., Rossi, G., Catani, F. (2020). Characterization of Hillslope Deposits for Physically Based Landslide Forecasting Models. In Workshop on World Landslide Forum (pp. 265-272). Springer, Cham.