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

1. **Name of Organization**: Institute of Rock Structure and Mechanics Czech Academy of Sciences & Charles University, Faculty of Science
2. **Name of Leader**: RNDr. Josef STEMBERK, Ph.D.
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   Core members of the activities
   RNDr. Jan KLIMEŠ, Ph.D., IRSM CAS
   Mgr. Jan BLAHŮT, Ph.D., IRSM CAS

   Prof. Vít VILÍMEK, Ph.D. (Deputy Coordinator), Charles University, Faculty of Science
   Mgr. Jana SMOLÍKOVÁ, Charles University, Faculty of Science
3. **Date of Submission of Application**: August 9th, 2019
4. **Activity scale and targeted region:** Geomorphological research and engineering geological monitoring of landslides activity and their climatic drivers considering site specific and community-centered disaster risk reduction measures.
   Target regions: Intercontinental (with South and North America), continental (with Italy, Spain, Svalbard, Austria, Slovakia and Germany), national (various localities in Bohemian Massif and Western Carpathians).
5. **Short Title**: Community centered landslide disaster risk reduction in changing climate, continuation
6. **Objectives for the initial 3 years**:
   The WCoE will strengthen the IPL and the ISDR-ICL Sendai Partnerships 2015-2025 through new approaches of landslide hazard and risk assessment and their proper communication to the local communities and relevant end users. Following the Sendai Partnership aims it will focus on analysis of climatic triggers of dangerous landslides and knowledge exchange between experts and potentially affected entities.
7. **Background Justification:**
   The participating institutions have long-term experience in geomorphological research and systematic safety monitoring of unstable slopes in Europe as well as field work in developing countries (Peru, Ethiopia) and arctic regions (Svalbard). Many of the research results have been successfully applied for landslide risk reduction by local authorities, private companies (e.g. Peru, Czechia) or state agencies (Ministry of Transportation, Czechia) which required proper communication of the results and relevant collaboration with different end users. These achievements and our experience in landslide susceptibility mapping and risk assessment combined with the use of up-to-date field research technologies give us an

excellent opportunity to present the appealing topic of landslide risk reduction to the general public as well as university students. All these activities continuously contribute to the landslide risk reduction aims of the ISDR-ICL Sendai Partnerships.

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

The participation organizations will provide research and technical staff, indoor laboratories as well as field geodynamical laboratories located on long term monitored landslides (more than 10 years); two types of house-developed landslide monitoring devices; world-wide geodynamical monitoring network providing data about landslides/tectonic interactions (EU TecNet, http://www.irsm.cas.cz/ext/tecnet/index_en.php); field research facilities including terrestrial laser scanner, high precision GPS stations, optical and thermal cameras on UAV; PhD students, staff and laboratories at Faculty of Science (Charles University). In addition, the proposed WCoE closely collaborates with full (Brown Coal Research Institute) and Associate (Czech Geological Survey) members from the Czechia who will significantly enlarge the available resources for the WCoE. The financial support for the planned research is provided from various, mainly national sources (e.g. Grant Agency and Technology Agency of the Czechia, Grant Agency of Charles University, Ministry of Education – one project, Ministry of Environment – one project). Recently, we work on two IPL projects, collaborate within 2 ICL/IPL Networks and actively participate on ICL/IPL-GPC activities (IPL conferences, evaluations of IPL projects, organization of World Landslide Forum).

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

Our WCoE focused on three main activities – compiling landslide-related databases; landslide monitoring and hazard assessment and searching new ways of transferring the research results to the public. Currently we maintain world-wide databases summarizing published results on megalandslides from volcanic islands (https://www.irsm.cas.cz/ext/giantlandslides/index.php?page=giantlandslides_db; Blahut et al., 2018) and national database of landslide occurrences captured by the Czech media.

Landslide susceptibility and hazard assessments were performed on the country-wide (Czechia, Racek & Blahut under preparation) and mountain range (Peru, Bueechi et al., 2018) scales and with the use of InSAR data analysis on local scales (Strozzi et al., 2018). We also further developed our landslide monitoring network in the Czechia with focus on temperature driven rock slope deformations. We published results of the monitoring of shallow (Balek et al., submitted) as well as deep-seated landslide movements (Šilhán et al., submitted; Stember & Briestensky submitted) including megalandslides on volcanic islands (Blahut et al., 2018) and also reconstruction of large run-out landslide (Burda et al., 2018). We continued research of climatically driven rock slope movements in Arctic region, Svalbard (Hartvich et al., 2017) and tropical glaciated mountains, Peru (Emmer et al., submitted) including bilateral research on landslide dams with the Florence University, Italy (Tacconi et al., 2018) and effectiveness of remedial works for glacial lake outburst floods (Emmer et al., 2018). Our research also

focused on community oriented landslide disaster risk reduction and adaptation measures in rural areas of Peru (Klimeš et al., 2019) and Czechia (Klimeš et al., under preparation) and we also initiated a collection of thematic papers dedicated to this topic, which will be published in Landslide journal this year.

The main activities related to the public awareness about landslide risk reduction included: **i)** 3 workshops for experts, technicians and civil administration including members of the Parliament; **ii)** series of articles for general public (in Czech); **iii)** publication of two brochures dedicated to general public and local administrations explaining the landslide hazard reduction under the legal and environmental framework of the Czechia; **iv)** public talks and hiking excursion; **v)** preparation of series of short videos about village seriously damaged by landslide in Czechia; **vi)** further development of Earthcaching logs dedicated to landslide hazard in collaboration with Czech national parks; **vii)** preparation of exhibition about landslides in collaboration with artists; **viii)** field course of landslide monitoring with geodetic methods, Huaráz, Peru; **ix)** teaching on the 2nd International Summer School (Pavia, Lombardy, Italy).

New full and Associate ICL members from Czechia - Research Institute of Brown Coal Mining and Czech Geological Survey jointed the ICL in 2019. **Four undergraduate thesis** focused on landslide research were defended and **two new PhD** positions at the Charles University, Prague were opened.

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

Our future activities will stress several topics including in-depth research of the temperature effects on rock slope stability using already available monitoring sites and newly instrumented locations in Czechia, Svalbard and Peru. The new monitoring will focus on historical sites endangered by landslides. The other activity will be analysis of triggering precipitation in order to set up rainfall thresholds. We will also focus on the community-oriented solutions (including the citizen science approach) for the landslide disaster risk reduction in developed (Czechia) as well as developing (Peru) countries while maintaining communication with central governmental agencies and politicians through workshops and conferences.

a) Monitoring of slope stability conditions including environmental variables (e.g. temperature, precipitation) ……..……..……. 1. – 3. year

b) Analysis and interpretation of results of the long-term landslide monitoring with respect to landslide hazard and effective mitigation strategies…...…...……...…... 2. – 3. year

c) Capacity building – teaching of undergraduate and PhD students from developed and developing countries, field training during regular conferences “Slope movements and pseudokarst”, presentation of research results to potentially affected communities in Czechia and Peru…… ……..……1. – 3. year

Expected results: scientific publications; articles and interviews in various media to present gained results to the public; methods for the best practice, cost-effective and long-term landslide risk management; susceptibility, hazard and risk maps; communication of the scientific results to local communities in different cultural and economic context; maintaining landslide related databases.

11. **Beneficiaries of WCoE:**

Among the direct beneficiaries at the national level will be local forest managers, village administrations and other state agencies (e.g. Ministry of Transportation) while the local communities and research institutions in the foreign research sites will benefit most from the WCoE results, which will be applicable for regional planning and risk governance. The international scientific community, including university students (national as well as foreign) will benefit from the published scientific results.

12. **References (used in the text):**

Balek J, et al. **(submitted)**: Shallow landslide movements in clay rich rocks detected during subnormal precipitation period. Acta Geodynamica et Geomaterialia; **Blahut J** et al. **(2018)** Database of giant landslides on volcanic islands - first results from the Atlantic Ocean. Landslides, 15: 823-827.; **Blahut** J, et al. **(2018)** Large landslide stress states calculated during extreme climatic and tectonic events on El Hierro, Canary Islandst, Landslides, 15, 1801 – 1814.; **Bueechi** E, et al. **(2019)** Regional-Scale Landslide Susceptibility Modelling in the Cordillera Blanca, Peru - A Comparison of Different Approaches. Landslides, 16: 395 - 407.; **Burda J**, et al. **(2018)**: Reconstruction of a large run-out landslide in the Krušné hory Mts. (Czech Republic). Landslides, 15, 3, 423-437.; **Emmer** A, et al. **(2016)**: 882 lakes of the Cordillera Blanca: An inventory, classification, evolution and assessment of susceptibility to outburst flood. Catena, 147, 269-279.; **Tacconi** C, et al. **(2018)**: Morphological analysis and features of the landslide dams in the Cordillera Blanca. Landslides, 15, 3, 507-521.; **Emmer** A, et al. **(submitted)** Distinct types of landslides in moraines associated with the post-LIA glacier thinning: observations from the Kinzl glacier, Huascarán, Peru. Sci Total Enviro; **Hartvich** F, et al. **(2017)**: Rock avalanche and rock glacier: A compound landform study from Hornsund, Svalbard. Geomorphology, 276(1): 244-256.; **Klimeš** J, et al. **(2019)** Community participation in landslide risk reduction: a case history from Central Andes, Peru. Landslides; **Klimeš** J, et al. **(under prep.)** Landslide hazard and risk history of rural community in the Outer Western Carpathians, Czechia. Applied Geography; **Racek** O, **Blahut** J **(under prep.)** National-wide susceptibility modelling of Czechia. Landslides; **Strozzi** T, et al. **(2018)** Satellite SAR Interferometry for the Improved Assessment of the State of Activity of Landslides: A Case Study from the Cordilleras of Peru. Remote Sens Enviro, 217: 111-125.; **Stemberk** J, **Briestenský** M **(submitted)**: Tectonic strain affecting the deep-seated gravitational slope deformations dynamics. Engineering Geology; **Šilhán** K, et al. **(submitted)**: The sensitivity of dendrogeomorphic approach to landslide movements. Geomorphology;

13. **If your organization is an ongoing WCoE 2017-2020, 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:**

- Blahut J, Klimeš J, Rowberry M, Kusák M (2018) Database of giant landslides on volcanic islands - first results from the Atlantic Ocean. Landslides, 15: 823-827. **(IPL project)**

- Klimeš J, Stemberk J, Blahut J, Krejčí V, Krejčí O, Hartvich F, Kycl P (2017) Challenges for landslide hazard and risk management in 'low-risk' regions, Czechia—landslide occurrences and related costs (IPL project no. 197). Landslides, 14, 771 – 780. **(IPL project)**
- Blahut J, Rowberry MD, Balek J, Klimeš J, Baroň I, Meletlidis S, Martí X (2017) Monitoring Giant Landslide Detachment Planes in the Era of Big Data Analytics. In: Mikoš M., Arbanas Ž., Yin Y., Sassa K. (eds) Advancing Culture of Living with Landslides. WLF 2017. Springer, Cham. **(WCoE)**
- Blahut J, Balek J, Klimeš J, Rowberry MD, Kusák M, Kalina J (submitted) Database of giant landslides from volcanic islands. Landslides. **(IPL project)**

14. List of published or planned reports of WCoE 2017-2020 in journal "Landslides" or "WLF5 books" for ongoing WCoE organization.

- Klimeš J, Hartvich F, Tábořík P, Blahut J, Briestensky M, Stember J, Emmer A, Vargas R, Balek J (2017) Studies on selected landslides and their societal impacts: activity report of the Prague World Centre of Excellence, Czechia. Landslides, 14: 1547-1553. doi:10.1007/s10346-017-0837-4
- Stemberk J., Vilímek V., Klimeš J., Blahůt J., Hartvich F., Balek J. (2017) Landslide Hazard and Risk Management (WCoE 2014–2017). In: Sassa K., Mikoš M., Yin Y. (eds) Advancing Culture of Living with Landslides. WLF 2017. Springer, Cham, 373 - 377.
- Vilímek V, Klimeš J, Mamani RV, Abuhadba JB, Victoria FA, Champi PZ (under preparation) Contribution of the collaborative effort of the WCoE to the landslide risk reduction at Machu Picchu World heritage site, Peru. Landslides
- Klimeš J et al. (under preparation) Arts for enhancing communication of landslide research to the public? Experiences from the preparation of the exhibition "Life in Earth Scars". (WCoE 2017–2020). In: Sassa K (eds) Advancing Culture of Living with Landslides. WLF 2020. Springer
- Stemberk J et al. (under preparation) Towards landslide risk reduction along transportation corridors in the Cezch Republic through improved geotechnical survey practices (WCoE 2017–2020). In: Sassa K (eds) Advancing Culture of Living with Landslides. WLF 2020. Springer
- Vilímek V. et al. (under preparation): Landslides as triggers of lake outburst floods in the Cordillera Blanca, Peru (WCoE 2017-2020). Landslides triggered by extreme rainfall and effect of climate change. WLF 2020. Springer