\<D25-2\>

Application Form for World Centre of Excellence on Landslide Risk Reduction 2023-2026

1. Name of Organization

University of Belgrade, Faculty of Mining and Geology, Belgrade, Serbia

2. Name of Leader **Prof. Biljana Abolmasov, PhD**

    Affiliation: Full Professor, Dean of the Faculty of Mining and Geology

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    biljana.abolmasov@rgf.bg.ac.rs

    Core members of the activities Names/Affiliations: (4 individuals maximum)

    Assoc. Prof. Miloš Marjanović, PhD (University of Belgrade, Faculty of Mining and Geology, Belgrade, Serbia)

    Assoc. Prof. Ranka Stanković, PhD (University of Belgrade, Faculty of Mining and Geology, Belgrade, Serbia)

    Assoc. Prof. Mileva Samardžić-Petrović, PhD (University of Belgrade, Faculty of Civil Engineering, Belgrade, Serbia)

    Assist. Uroš Đurić, PhD (University of Belgrade, Faculty of Civil Engineering, Belgrade, Serbia)

    PhD students: Jelka Krušić, Cvjetko Sandić, Ksenija Micić, Pavle Manasijević (all from University of Belgrade, Faculty of Mining and Geology, Belgrade, Serbia)

3. Date of Submission of Application 30 March 2023

4. Activity scale and targeted region.

    1) Global, 2) Intercontinental, 3) Continental, **4) Regional, 5) National**

5. Short Title characterizing past and planned activities (10 words maximum)

Integrated approach to landslide risk management in climate changing conditions – (continuation of WCoE 2017-2020, 2020-2023)

6. Objectives for 3 years: (5 lines maximum; what you expect to accomplish?)

    1) Harmonization of landslides and climate related data for municipalities and for local/national road network

    2) Capacity building for landslide event recording in selected municipalities and for local/national road authorities and services

    3) Development of Android and iOS mobile applications for landslide recording and open landslides

data on web portal (CliRtheRoads and MaPLoRoads)

4) Improving land use planning documents for selected municipalities (landslide inventory and susceptibility/hazard/risk maps) in climate changing conditions (according to the national climate changing models)

5) Improving landslide risk management for local/national road network (from landslide inventory to landslide risk management) in climate changing conditions (according to the national climate changing models)

7. Background Justification: (10 lines maximum)

Landslides, rockfalls, flash floods and floods are commonly imposing damage to state and local road network in Serbia. These occurrences intensified in the past couple of decades in the climate changing conditions, especially outbreaking in 2006, 2010 and 2014. At the time, disastrous effects were closely followed in media and public and handled by responsible state services and volunteers, but little has been done after the waters retreated and landslides settled. Reported occurrences were suffering from uneven quality, consistency and coverage, so the first steps required standardizing and harmonizing historical data and generating compatible templates for collecting future data. Such inventories were first intended for the state-of-the-art hazard and risk analysis, rainfall thresholding, potentially leading to development of early-warning system. The aim of WCoE is to standardize landslide data acquisition by closely involving local communities and road authorities, while preparing them to cope with landslides in the future, leading to more secure, better prepared and more resilient.

8. Resources available for WCoE activities

Personnel, Facilities, Budgets, and Affiliation and Contribution to ICL/IPL and KLC2020.

University of Belgrade, Faculty of Mining and Geology (FMG) staff and PhD students (from Department of Geotechnics and IT Center of FMG) will provide personnel, software, technical, laboratory, IT and other facilities support for realization of WCoE objectives. Faculty of Mining and Geology team members are already supporting follow-up activities of UNDP Project BEWARE (http://geoliss.mre.gov.rs/beware/) by teaching, trainings and workshops for local authorities and maintenance of open access landslide data base. Faculty staff is supporting National and Local Self-governmental Road authorities for harmonization of landslide data, hazard and risk assessment as well as landslide risk management on the road transport network in Serbia. Budget for planned activities is expected to be covered by on-going Team members consultancy service and national project activities.

Faculty of Mining and Geology has been ICL member since 2011. and active member of Adriatic-Balkan ICL/IPL Network. Also we are Signatories of KLC2020 from 2019. Two on-going IPL Projects (IPL 181 and IPL 210) are thematically related to WCoE ongoing and future activities. Additionally, IPL Project ―Innovation in slow-moving landslide risk assessment of roads and urban sites by combining multi-sensor multi-source monitoring data‖ with University of Salerno, Italy, is also supporting WCoE on-going and planned activities. Also we are contributing to the JTC-1 Commission, LARAM school Scientific Committee, and IAEG/ISRM activities.

9. Description of your past activities related to risk reduction of landslides and other related earth system disasters (30 lines maximum)

Taking part in various projects related to the topic:

1) Project „Improving Resilience and Safety of the Local Road Transport Network in the Republic of Serbia‖ funded by Japan - The World Bank Program for Mainstreaming Disaster Risk Management in Developing Countries (2022 - ongoing).

2) National Project funded by Ministry of Science, Technological Development and Innovations of the Republic of Serbia (2020 - ongoing)

3) Project ―Mainstreaming climate resilience in the road transportation management in Serbia‖, funded by The World Bank and GFDRR, (2017-2021).

4) Project ‖Technical Assistance Preparation of Climate Resilience Design Guidelines for the Public Enterprise for State Roads in North Macedonia‖, funded by World Bank, (2018-2019).

5) Project ―Road Geohazard Risk Management Handbook and Toolkit-Serbian Case Study‖, funded by World Bank and Government of Japan, (2016-2017)

6) Project ―BEWARE - BEyond landslide aWAREness‖, funded by Government of Japan and coordinated by UNDP Serbia, (2015-2016).

7) Project ―Development of flood and landslide risk assessment for the housing sector in Bosnia and Herzegovina‖, HEIS, Sarajevo, coordinated by UNDP Bosnia and Herzegovina, (2014-2015).

8) Project „Detailed flood and landslide risk assessment for the urban areas of Tuzla and Doboj―, HEIS, Sarajevo, coordinated by UNDP Bosnia and Herzegovina, (2015-2016).

9) Study ―Study on landslide risk management in Bosnia and Herzegovina‖, funded by UNDP Bosnia and Herzegovina (2015-2016).

10) Participation in Recovery Needs Assessment (RNA) Serbia - PDNA for Serbia 2014, Sector Environment, UNDP Serbia, World Bank and European Commission (2014)

11) Bilateral Project with the Republic of Slovenia for project cycle 2012-2013 ―Adria-Balkan Regional

Network: Landslide Risk Mitigation For Society And Environment— funded by Ministry for Science and Technology of the Republic of Serbia with University of Ljubljana, Faculty of Civil Engineering

12) Bilateral Project with the Republic of Croatia for project cycle 2010-2012, —Geohazardinfo: Virtual Geohazards Data Centre—, funded by Ministry for Science and Technology of the Republic of Serbia with University of Zagreb, Faculty of Geology, Mining and Petroleum Engineering

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

Collecting and harmonization of historical landslide data, by using templates in accordance to the International classification and standards. *Milestone* is a collection of landslide reports with standardized contents, gathered from road and other infrastructure. *Work phases*: **Phase 1** - collecting reports from historical archives in cooperation with several companies with geotechnical agenda (such as The Highway Institute, The Roads of Serbia, Ministry of Construction, Transport and Infrastructure, Ministry of Interior etc.), as well as national authorities, **Phase 2** - collecting reports from these parties in their future work.

Digital collection of new landslide data, by using mobile applications, by local users or crowd sourcing. *Milestone:* applications and linked landslide database with essential data (location, date, type, etc.). **Phase 1** – development of mobile app for Android and iOS. **Phase 2** – a database that will host the collected data. **Phase 3** – generating reports, maps and tables useful for general, preliminary level of planning and decision-making.

Collecting and analyzing rainfall data, by using data from national Hydro-meteorological Service of Serbia (www.hidmet.gov.rs), Public Enterprise Roads of Serbia, as well as downscaling climate data from CLIMAPROOF project (https://data.ccca.ac.at). *Milestone:* cross-correlating rainfall and landslide data and updating thresholds determined for May 2014 event especially in the climate changing context.

Capacity building for local/national authorities, follow-up activities - teaching, training and workshops for local and national representatives (municipalities staff, road authority staff in collecting/updating the data).

Landslides - land use planning and risk management, stimulating using of landslide data in spatial and urban planning at local/national level; using of landslide data in road transportation risk management.

Open landslides data, making collected data available for preview and download, thereby raising awareness and stimulating cooperating. *Milestone*: universal landslide database on national level and linked web portal.

11. Beneficiaries of WCoE: (5 lines maximum; who directly benefits from the work?)

Direct beneficiaries of WCoE activities will be local/national authorities and offices of emergency management sector and Civil protection units in municipalities affected by landslides and other climate

related mass movements. Open landslide database will be provided for local and regional stakeholders/authorities and services through WCoE activities. Indirect beneficiaries will be Geological Survey of Serbia and Public Enterprise Roads of Serbia (as Public Institution) and the Ministry for Mining and Energy, the Ministry of Construction, Transport and Infrastructure and the Ministry of Interior of the Republic of Serbia (as Governmental Institutions). Indirect beneficiaries will be also wider landslides community on national, regional and international level.

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

1) Sandić C., Marjanović M., Abolmasov B., Tošić R. (2023) Integrating landslide magnitude in the susceptibility assessment of the City of Doboj, using machine learning and heuristic approach, *Journal of Maps*, 1-10. DOI: 10.1080/17445647.2022.2163199 https://doi.org/10.1080/17445647.2022.2163199

2) Đurić U., Abolmasov B., Marjanović M.S., Jocković S., Marjanović M.D. (2022) A proposal for the landslide damage questionnaire in suburban areas. In: Peranić J., Vivoda Prodan M., Bernat Gazibara S., Krkač M., Mihalić Arbanas S. and Arbanas Ž. (eds). Landslide Modelling & Applications. Proceedings of the 5th Regional Symposium on Landslides in the Adriatic-Balkan Region. Croatian Landslide Group University of Rijeka, Faculty of Civil Engineering University of Zagreb, Faculty of Mining, Geology and Petroleum Engineering, pp 125-130. https://5resylab.uniri.hr/wp-content/uploads/2022/04/2_Proceedings-of-the-5th-ReSyLAB.pdf

3) Marjanović M., Abolmasov B., Đurić U., Krušić J., Bogdanović S. (2022) Regional rockfall exposure assessment, experience from Serbia. In: Peranić J., Vivoda Prodan M., Bernat Gazibara S., Krkač M., Mihalić Arbanas S. and Arbanas Ž. (eds). Landslide Modelling & Applications. Proceedings of the 5th Regional Symposium on Landslides in the Adriatic-Balkan Region. Croatian Landslide Group University of Rijeka, Faculty of Civil Engineering University of Zagreb, Faculty of Mining, Geology and Petroleum Engineering, pp 145-150. https://5resylab.uniri.hr/wp-content/uploads/2022/04/2_Proceedings-of-the-5th-ReSyLAB.pdf

4) Abolmasov B., Skempas M., Milenković S., Radovanović J., Marjanović M. (2022) Highway construction in fossil landslides zones – Lessons learned from the Grdelica Gorge, Serbia. In: Peranić J., Vivoda Prodan M., Bernat Gazibara S., Krkač M., Mihalić Arbanas S. and Arbanas Ž. (eds). Landslide Modelling & Applications. Proceedings of the 5th Regional Symposium on Landslides in the Adriatic-Balkan Region. Croatian Landslide Group University of Rijeka, Faculty of Civil Engineering University of Zagreb, Faculty of Mining, Geology and Petroleum Engineering, pp 237-242. https://5resylab.uniri.hr/wp-content/uploads/2022/04/2_Proceedings-of-the-5th-ReSyLAB.pdf

5) Abolmasov B., Đurić U., Popović J., Pejić M., Samardžić Petrović M., Brodić N. (2020) Results of Recent Monitoring Activities on Landslide Umka, Belgrade, Serbia—IPL 181. In: Sassa K., Mikoš M.,

Sassa S., Bobrowsky P.T., Takara K., Dang K. (eds) Understanding and Reducing Landslide Disaster Risk. WLF 2020. ICL Contribution to Landslide Disaster Risk Reduction. Springer, Cham. Pp 225-234. https://doi.org/10.1007/978-3-030-60196-6_14

6) Abolmasov B., Petrović M.S., Stanković R., Marjanović M., Krušić J., Đurić U. (2020) Extreme Rainfall Event and Its Aftermath Analysis—IPL 210 Project Progress Report. In: Sassa K., Mikoš M., Sassa S., Bobrowsky P.T., Takara K., Dang K. (eds) Understanding and Reducing Landslide Disaster Risk. WLF 2020. ICL Contribution to Landslide Disaster Risk Reduction. Springer, Cham. Pp. 267-273. https://doi.org/10.1007/978-3-030-60196-6_19

7) Krušić J., Abolmasov B., Marjanović M. (2020) Numerical Models of Debris Flows with Entrainment Analysis-Case Studies from the Republic of Serbia. In: Tiwari B., Sassa K., Bobrowsky P.T., Takara K. (eds) Understanding and Reducing Landslide Disaster Risk. WLF 2020. ICL Contribution to Landslide Disaster Risk Reduction. Springer, Cham. pp.267 -272 https://doi.org/10.1007/978-3-030-60706-7_25

8) Marjanović M., Abolmasov B., Peshevski I., Reeves J., Georgievska I. (2020) Regional Slope Stability Analysis in Landslide Hazard Assessment Context, North Macedonia Example. In: Guzzetti F., Mihalić Arbanas S., Reichenbach P., Sassa K., Bobrowsky P.T., Takara K. (eds) Understanding and Reducing Landslide Disaster Risk. WLF 2020. ICL Contribution to Landslide Disaster Risk Reduction. Springer, Cham.pp 267-273. https://doi.org/10.1007/978-3-030-60227-7_29

9) Marjanović M., Abolmasov B., Sandić C., Mulać M., Begović P. (2021). Quantitative landslide risk assessment in the city of Tuzla. SCG-XIII International Symposium on Landslides. Cartagena, Colombia-June 15th-19th-2020. ISL2020-102.pdf. https://www.issmge.org/publications/online-library

10) Krušić J., Abolmasov B., Marjanović M., Pastor M., Tayyebi S.M. (2021). Numerical modelling of Selanac debris flow propagation using SPH code. SCG-XIII International Symposium on Landslides. Cartagena, Colombia- June 15th-19th-2020. ISL2020-109.pdf. https://www.issmge.org/publications/online-library

11) Marjanović M., Abolmasov B., Milenković S., Đurić U., Krušić J., Samardžić Petrović M. (2019). Multihazard Exposure Assessment on the Valjevo City Road Network. Spatial Modeling in GIS and R for Earth and Environmental Sciences, H. R. Pourghasemi and C. Gokceoglu (eds), Elsevier Inc., pp 671-688. ISBN 978-0-12-815226-3 DOI: https://doi.org/10.1016/B978-0-12-815226-3.00031-4.

12) Krušić J., Abolmasov B., Samardžić Petrović M. (2019). Influence of DEM resolution on numerical modelling of debris flows in RAMMS - Selanac case study. Uljarević M., Zekan S., Ibrahimović Dž. (eds.): Proceedings of the 4th Regional Symposium on Landslides in the Adriatic Balkan Region, 23-25 October 2019, Sarajevo, Bosnia and Herzegovina. Geotechnical Society of Bosnia and Herzegovina, 2019. doi: https://doi.org/ 10.35123/ReSyLAB_2019, 163 - 168. ISBN 978-9926-8400-0-6

13) Marjanović M., Samardžić-Petrović M., Abolmasov B., Đurić U. (2019). Concepts for Improving Machine Learning Based Landslide Assessment. Springer Nature Switzerland AG 2019. H. R. Pourghasemi

and M. Rossi (eds.), Natural Hazards GIS-based Spatial Modeling Using Data Mining Techniques, Advances in Natural and Technological Hazards Research 48, pp 27-58. ISBN 978-3-319-73382-1 https://doi.org/10.1007/978-3-319-73383-8_2

14) Marjanović M., Krautblatter M., Abolmasov B., Đurić U., Sandić C., Nikolić V. (2018). The rainfall-induced landsliding in Western Serbia: A temporal prediction approach using Decision Tree technique. *Engineering Geology* 232: 147–159. https://doi.org/10.1016/j.enggeo.2017.11.021

15) Đurić D., Mladenović A., Pešić-Georgiadis M., Marjanović M., Abolmasov B. (2017). Using multiresolution and multitemporal satellite data for post disaster landslide inventory in the Republic of Serbia. *Landslide*s 14 (4): 1467-1482. DOI 10.1007/s10346-017-0847-2

16) Krušić J., Marjanović M., Samarđić-Petrović M., Abolmasov B., Andrejev K., Miladinović A. (2017). Comparison of expert, deterministic and Machine Learning approach for landslide susceptibility assessment in Ljubovija Municipality, Serbia. *Geofizika* 34 (2): 251-273. doi 10.15233/gfz.2017.34.15

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.‖
    − We provided links to the published articles.
    − Continuation on KLC 2020 activities (on international, national, regional and local level) within WCoE as well on IPL Projects
    − Application on the new IPL Project with ICL Associates - University of Salerno and Geotechnical Society of North Macedonia in 2023
    − Organization of 6th ReSyLAB in May 2024 in Belgrade, Serbia (ICL Adriatic Balkan Network)
    − Publishing in Landslides and other Journals and ―P-LRT books.‖ (Vol.2, 2) and WLF6

    (Those organizations with no activity report/no achievement in WCOE 2020-2023 will not be accepted as the candidate of WCOE 2023-2026 to be submitted to the Independent Panel of Experts for WCOEs.)

Note: Please fill and submit this form by 30 March 2023 to **KLC2020 secretariat** <klc2020@iclhq.org>