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

1. Name of Organization **University of Belgrade, Faculty of Mining and Geology, Belgrade, Serbia**
2. **Name of Leader**: **Prof. Biljana Abolmasov, PhD**

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   Core members of the activities

   Asst. Prof. Milos Marjanović, PhD

   Assoc. Prof. Ranka Stanković, PhD

   Asst. Prof. Mileva Samardžić-Petrović, PhD

   Asst. Prof. Zoran Berisavljević, PhD

   Uros Djuric, PhD student, Jelka Krusic, PhD student, Cvjetko Sandić, PhD student
3. Date of Submission of Application: 12 October 2019
4. **Activity scale and targeted region**.

   1) Global, 2) Intercontinental, 3) Continental, 4) **Regional**, 5) **National**
5. Short Title **Harmonization of Landslides Data and National Authorities Capacity Building for Landslide Risk Reduction - continuation**
6. **Objectives for the initial 3 years**: (5 lines maximum; what you expect to accomplish?)
   1) Harmonization of landslides data for municipalities and road network affected by extreme rainfall during May 2014 in Serbia (pre event and post event data)
   2) Capacity building for landslide event recording in selected municipalities and road authorities
   3) Improving land use planning documents for selected municipalities (landslide inventory and susceptibility/hazard/risk maps)
   4) Improving landslide risk management for road network (from landslide inventory to landslide risk management)
   5) Open landslides data on web portal (for Local and National Authorities)

7. **Background Justification**: (10 lines maximum)

   The usual landslide triggers are floods and high-yield rainfall, which was the case in the catastrophic

cyclone Tamara episode that stroke Serbia and surrounding countries in May 2014. At the time, disastrous effects were closely followed in media and public and handled by responsible state services, such as Civil Protection offices, and volunteers, but little has been done after the waters retreated and landslides settled, especially regarding landslide analysis and mitigation. Landslide events reports (in analogue form) greatly understated the realistic number of landslides (concentrating more on urgent/acute cases), while report quality standard and consistency was uneven (because they were collected by different institutions, depending on the acute needs), so resulting inventories remained incomplete and far from standardized. In this respect, it was essential to produce unified large-scale inventories of May 2014 event and beyond, and use them for the state-of-the-art hazard and risk analysis, potentially leading to development of early-warning system. It was the only way to actually learn from catastrophes, i.e. to prepare better, react quicker, assess more efficiently and more accurately in the future. The overall aim of WCoE is to standardize post-event landslide database and closely involve local communities and road authorities in municipalities affected by May 2014 rainfall event in Serbia, and prepare them to cope with landslides events in the future. This will lead to more secure, better prepared and more resilient communities and road transportation network in climate changing conditions.

8. **Resources available for WCoE activities**

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

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 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 is an ICL member from 2011 and active member of Adriatic-Balkan ICL/IPL Network. Two on-going IPL Projects (IPL 181 and IPL 210) are thematically related to WCoE ongoing and future activities. Additionally, new 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 approved during ICL/IPL Conference in Paris, 2019.

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

disasters (30 lines maximum)

1) National Project funded by Ministry of Education, Science and Technological Development of the Republic of Serbia “The application of GNSS and LIDAR technology for infrastructure facilities and terrain stability monitoring” (2011- ongoing)
2) 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).
3) Project “Mainstreaming climate resilience in the road transportation management in Serbia”, funded by World Bank and GFDRR, (2017-2018).
4) Project “Road Geohazard Risk Management Handbook and Toolkit/Serbian Case Study”, funded by World Bank and Government of Japan, (2016-2017)
5) Project “BEWARE - **BE**yond landslide a**WARE**ness”, funded by Government of Japan and coordinated by UNDP Serbia, (2015-2016).
6) 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).
7) 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).
8) Study “Study on landslide risk management in Bosnia and Herzegovina”, funded by UNDP Bosnia and Herzegovina (2015-2016).
9) Participation in Recovery Needs Assessment (RNA) Serbia - PDNA for Serbia 2014, Sector Environment, UNDP Serbia, World Bank and European Commission (2014)
10) German National Aeronautics and Space Research Centre (DLR), TerraSARX archived data utilization project: Measuring ground displacement using InSAR techniques, GEO2806, (2014-2015).
11) Postdoc research project of Technische Universität München Foundation Fellowship: Application of different landslide monitoring techniques at Chair of Landslide Research, (2014-2015).
12) 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
13) 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)
    1) **Collecting and harmonization of pre and post event (May 2014) landslide data**, by using professional geotechnical reports according to the International classification and standards. *Expected result* is a collection of landslide reports with standardized contents, gathered from road and infrastructure and similar geotechnical project reports. *Work phases* are as follows: **Phase 1** - collecting reports from archives before the May 2014 event (dating up to 15 years back) by cooperating 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.), **Phase 2** - collecting reports from these companies in their future work.
    2) **Collecting and harmonization of landslide data from local and national authorities**, similarly as above, but from governmental and local authority sources, with different, more basic data content, and with accent on new, unreported landslides. The BEWARE project platform provides opportunity to local communities to update and report new landslides data (follow-up activities).
    3) **Collecting and analyzing rainfall data**, by using available data from national Hydro-meteorological Service of Serbia (www.hidmet.gov.rs) and data from Public Enterprise Roads of Serbia. *Milestone* would be cross-correlating rainfall and landslide data for May 2014 event and pre-event and post-event data and cross-correlation with National Climate Change Models.
    4) **Capacity building for local/national authorities**, follow-up activities - teaching, training and workshops for local and national representatives (*municipalities'* local staff, *road authorities* staff in collecting/updating landslide data).
    5) **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 assessment and management.
    6) **Open landslides data**, making collected data available for preview and download through interactive web portal, thereby rising awareness and stimulating various agencies and individuals for cooperating in landslide database updating. *Milestone* is a universal and live landslide database on national level.
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 in 24 municipalities affected by extreme rainfall during 2014 in western and central part of Serbia. Open landslide data base will be provided for local and regional stakeholders and services through WCoE activities. Indirect beneficiaries will be Geological Survey of Serbia and Public Enterprise

Roads of Serbia (as Public Institution) and Ministry for Mining and Energy, Ministry of Construction, Transport and Infrastructure and Ministry of Interior of the Republic of Serbia (as Governmental Institutions).

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

1) 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
2) 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
3) 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
4) Marjanović M., Bajat B., Abolmasov B., Kovaćević M. (2018). Machine Learning and Landslide Assessment in a GIS Environment**.** In (Eds: Jean-Claude Thill and Suzana Dragicevic). Geo Computational Analysis and Modeling of Regional Systems, Part of Advances in Geographic Information Science Book Series (AGIS), pp 191-213. Springer International Publishing Ag, Part of Springer Nature. https://link.springer.com/chapter/10.1007/978-3-319-59511-5_11
5) 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, pp 671-688. Elsevier Inc. DOI: https://doi.org/10.1016/B978-0-12-815226-3.00031-4.
6) 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. https://doi.org/10.1007/978-3-319-73383-8_2
7) Đurić U., Marjanović M., Radić Z., Abolmasov B. (2019). Machine learning based landslide assessment of the Belgrade metropolitan area: Pixel resolution effects and a cross-scaling concept. *Engineering Geology* 256: 23-38. DOI:10.1016/j.enggeo.2019.05.007
8) Peshevski I., Jovanovski M., Abolmasov B., Papic J., Đurić U., Marjanović M., Haque U., Nedelkovska N. (2019). Preliminary regional landslide susceptibility assessment using limited data. *Geologica Croatica* 72 (1): 81-92. doi: 10.4154/gc.2019.03

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. **N/A**
14. **List of published or planned reports of WCOE 2017-2020 in journal "Landslides" or "WLF5 books" for ongoing WCOE organization**.
    1) 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
    2) 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
    3) Abolmasov B., Marjanović M., Milenković S., Đurić U., Jelisavac B., Pejić M. (2017). Study of Slow Moving Landslide Umka Near Belgrade, Serbia (IPL-181). In: K. Sassa et al. (eds.), Advancing Culture of Living with Landslides, **Proceedings of 4th World Landslide Forum**, Ljubljana 29 May-02 June 2017. Vol. 1. pp. 419-427. Springer International Publishing. DOI 10.1007/978-3-319-59469-9_37
    4) Sandić C., Abolmasov B., Marjanović M., Begović P., Jolović B. (2017). Landslide Disaster and Relief Activities: A Case Study of Urban Area of Doboj City. In: M. Mikoš et al. (eds.), Advancing Culture of Living with Landslides, **Proceedings of 4th World Landslide Forum**, Ljubljana 29 May-02 June 2017. Vol. 3. pp. 383-393. Springer International Publishing. DOI 10.1007/978-3-319-53487-9_45.
    5) Abolmasov B., Marjanović M., Đurić U., Krušić J., Andrejev K. (2017). Massive Landsliding in Serbia Following Cyclone Tamara in May 2014 (IPL-210) In: K. Sassa et al. (eds.), Advancing Culture of Living with Landslides, **Proceedings of 4th World Landslide Forum**, Ljubljana 29 May-02 June 2017, Vol. 1. pp. 473-484. Springer International Publishing. DOI 10.1007/978-3-319-59469-9_4
    6) Abolmasov B., Damjanović D., Marjanović M., Stanković R., Nikolić V., Nedeljković S., Petrović Ž. (2017). Project BEWARE-Landslide Post-disaster Relief Activities for Local Communities in Serbia. In: M. Mikoš et al. (eds.), Advancing Culture of Living with Landslides, **Proceedings of 4th World Landslide Forum**, Ljubljana 29 May-02 June 2017. Vol 3. pp. 413-422. Springer International Publishing. DOI 10.1007/978-3-319-53487-9_48
    7) Andrejev K., Krušić J., Đurić U., Marjanović M., Abolmasov B. (2017). Relative Landslide Risk Assessment for the City of Valjevo. In: M. Mikoš et al. (eds.), Advancing Culture of Living with Landslides, **Proceedings of 4th World Landslide Forum**, Ljubljana 29 May-02 June 2017. Vol 3. pp. 525-523. Springer International Publishing. DOI 10.1007/978-3-319-53483-1_62

8) Erić V., Božić B., Pejić M., Abolmasov B., Pandžić J. (2017). Permanent geodetic monitoring of the Umka Landslide using GNSS techonology and GeoMoss system. **Proceedings of 2nd Regional Symposium on Landslides in the Adriatic-Balkan Region** - 2nd ReSyLAB 2015, Eds: Abolmasov B., Marjanović M., Đurić U., University of Belgrade, Faculty of Mining and Geology, Belgrade, Serbia, pp. 43-48. ISBN 978-86-7352-296-8. http://resylab2015.rgf.rs/

9) Peševski I., Jovanovski M., Abolmasov B. (2017). Landslide Susceptibility Modeling Using Arbitary Polinomal Method. **Procedings of 2nd Regional Symposium on Landslides in the Adriatic-Balkan Region** - 2nd ReSyLAB 2015, Eds: Abolmasov B., Marjanović M., Đurić U., University of Belgrade, Faculty of Mining and Geology, Belgrade, Serbia, pp. 137-142. ISBN 978-86-7352-296-8. http://resylab2015.rgf.rs/

10) Marjanović M., Abolmasov B., Đurić U., Bogdanović S., Krautblatter M. (2017). Landslide events in Serbia in May 2014: An overview. **Procedings of 2nd Regional Symposium on Landslides in the Adriatic-Balkan Region** - 2nd ReSyLAB 2015, Eds: Abolmasov B., Marjanović M., Đurić U., University of Belgrade, Faculty of Mining and Geology, Belgrade, Serbia, pp. 239-244. ISBN 978-86-7352-296-8 http://resylab2015.rgf.rs/

11) Krušić J., Andrejev K., Abolmasov B., Marjanović M.(2018). Preliminary results of the Selanac debris flow modelling in RAMS - a case study. **Proceeding of the 3rd Regional Symposium on Landslides in the Adriatic-Balkan Region**, Ljubljana 2017, 11 - 13 October 2017 Ljubljana, Slovenia, pp95-100. Geological Survey of Slovenia. ISBN 978-961-6498-58-6

12) Marjanović M., Abolmasov B., Pejić M., Bogdanović S., Samardžić Petrović M. (2018). Rockfall monitoring and simulation on a rock slope near Ljig in Serbia. **Proceeding of the 3rd Regional Symposium on Landslides in the Adriatic-Balkan Region**, Ljubljana 2017, 11 - 13 October 2017 Ljubljana, Slovenia, pp83-88. Geological Survey of Slovenia. ISBN 978-961-6498-58-6

13) Abolmasov B., Pejić M., Samardžić Petrović M., Đurić U., Milenković S. (2018) Automated GNSS monitoring of Umka landslide-Review of seven years experience and results. **Proceeding of the 3rd Regional Symposium on Landslides in the Adriatic-Balkan Region**, Ljubljana 2017, 11-13 October 2017 Ljubljana, Slovenia, pp65-70. Geological Survey of Slovenia. ISBN 978-961-6498-58-6

14) Đurić U., Abolmasov B., Marjanović M., Samardžić Petrović M., Pejić M., Brodić N., Popović J. (2018). IPL Project 181 – Study of slow moving landslide Umka near Belgrade, Serbia – progress report for 2017 & 2018. Proceeding of IPL Symposium on Landslides 2018, Organized by International Consortium on Landslides (ICL), 03 December 2018, Kyoto, Japan. Eds.Sassa K., Dang K. pp 41-45. ISBN 978-4-9903382-0-6

15) Abolmasov B., Marjanović M., Đurić U., Samardžić Petrović M., Krušić J. (2018). IPL Project 210 – Massive landsliding in Serbia following Cyclone Tamara in May 2014 - progress report. Proceeding of 2018 IPL Symposium on Landslides, Organized by International Consortium on Landslides (ICL), 03 December 2018, Kyoto, Japan. Eds.Sassa K., Dang K. pp 47-51. ISBN 978-4-9903382-0-6

16) Krušić J., Samardžić Petrović M., Marjanović M., Abolmasov B., Miljković S. (2018). Preliminary results of numerical modelling of debris flow - case study Leva reka, Serbia. Proceedings of the 16th Danube-European Conference - Geotechnical hazards and risks: Experiences and practices, vol. 2, Skopje, North Macedonia. Willey and Sons. pp 707-712.

17) Marjanović M., Abolmasov B., Đurić U., Krušić J. (2018). Assessment of landslide-related hazard and risk on the road network of the Valjevo city, Serbia. Proceedings of the 16th Danube-European Conference - Geotechnical hazards and risks: Experiences and practices, vol. 1, Skopje, North Macedonia. Willey and Sons. pp 365-370.

18) 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

19) Марјановић М., Аболмасов Б., Миленковић С. (2017). Процена ризика од клизишта на путној мрежи општине Крупањ. Зборник радова петог научно-стручног саветовања Пут и животна средина, Вршац 28-29 септембар 2017. стр. 491-500. ISBN 978-86-88541-08-4 (in Serbian)

20) Аболмасов Б. (2017). Утицај промена климе на процену хазарда од клизишта на путној мрежи Србије. Зборник радова петог научно-стручног саветовања Пут и животна средина, Вршац, 28-29 септембар 2017. стр. 18-31. ISBN 978-86-88541-08-4 (in Serbian)

21) Krušić J., Abolmasov B., Marjanović M., Đurić D. (2018). Preliminary results of Selanac debris flow modelling in RAMMS. 17th Serbian Geological Congress, May 17-20, Vrnjačka Banja, Serbia, 619-624

22) Krušić J., Marjanović M., Andrejev K., Abolmasov B. (2018). Assessment of landslide susceptibility using expert AHP method for the Ljubovija Municipality. 17th Serbian Geological Congress, May 17-20, Vrnjačka Banja, Serbia, 625-629

(Those organizations with no activity report/no achievement in WCOE 2017-2020 will not be accepted as the candidate of WCOE 2020-2023 to be submitted to the Independent Panel of Experts for WCOEs.)

Note: Please fill and submit this form by 31 October 2019 to ICL secretariat <secretariat@iclhq.org>