

## IPL Project Annual Report Form 2021

1 January 2021 to 31 December 2021

1. Project Title (IPL-181)

**“Study of Slow-Moving Landslide Umka Near Belgrade, Serbia”**

2. Main Project Fields

(1) Technology Development

Monitoring and Early Warning

3. Name of Project leader: Biljana Abolmasov, PhD

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Core members of the Project: Names/Affiliations

Ass. Prof. Uroš Djurić, University of Belgrade, Faculty of Civil Engineering

Prof. Miloš Marjanović, University of Belgrade, Faculty of Mining and Geology

Prof. Marko Pejić, University of Belgrade, Faculty of Civil Engineering

Prof. Jovan Popović, University of Belgrade, Faculty of Civil Engineering

Ass. Prof. Mileva Samardžić Petrović, University of Belgrade, Faculty of Civil Engineering

4. Objectives: (5 lines maximum)

The research objectives are directed towards continual monitoring of the proposed case study by combining different monitoring techniques. The ultimate goal would be aiding decision making and mitigation measures design for this particular case study.

5. Study Area: (2 lines maximum)

The study area is covering landslide Umka and surrounding area and it is located 25 km south west from Belgrade, Serbia.

6. Project Duration (1 line maximum)

Project duration - 2012-ongoing

7. Report

1) Progress in the project: (30 lines maximum)

Project IPL 181 – “Study of slow moving landslide Umka near Belgrade, Serbia” was approved in November 2012. Extensive archive documentation was collected from The Highway Institute as well as papers on Umka and Duboko landslides published on international and local scientific conferences. Results of field investigations and laboratory testing conducted in different phases were analyzed. Data from installed automated GNSS receiver, precipitation and Sava river level were analysed in parallel to these activities. Original paper were published in *Landslides Journal* in 2015 (see references). Location of the GNSS sensor (object point) placed in the landslide body had to be changed after December 2013 due to the technical reasons and it was moved on nearby/ neighboring location after May 2014. Inclinometer case was installed in April 2017 and six series of measurements were performed, but due to unexpected construction activities inclinometers tube was broken in July 2017. GNSS sensor was moved from object point because of technical reasons (systematic error on modem). Precipitation data from Belgrade MMS and level of Sava River from a Beljin station are continuously collected throughout the entire period on daily basis. According to the Project Plan and with collaboration with Military Geographical Institute ten time series of aero photo images were analysed. The PSInSAR data from Sentinel 1 and 2 were collected and analysed from 2016-2018. Conventional geodetic survey was established during 2018 and three series of measurements of 56 geodetic points were realized during 2018-2019. Additionally, data base of damages on buildings and other constructions were established according to the field inventory and unified questionnaire form. PhD student Uroš Đurić defended his PhD thesis “Quantitative risk assessment on Umka landslide near Belgrade” in September 2021. The Highway Institute started with new series of geotechnical investigations and geotechnical monitoring in December 2021 and we are expecting new monitoring results in 2022.

2) Statement of completion of the Project (15 lines maximum)

Further research of the Umka landslide will be concentrate on analysis Sentinel 1 and 2 PSInSAR data and coupling the current surface monitoring GNSS system with additional geodetic survey measurements, as well as new data from geotechnical monitoring analysis. Also, further monitoring activities will be supported through collaboration with University of Salerno and joint IPL Project 148.

3) Beneficiaries of Project for Science, Education and/or Society (15 lines maximum)

- a) Direct beneficiaries will be local community – owner and residents of the houses affected by landslide Umka (about 1000 people)
- b) Local and regional authorities – regional motorway is affected by landslide (about 10000 vehicles/day)

4) Results: (15 line maximum, e.g. publications)

The list of publications in the framework the project is as follows:

- Đurić U. 2021. “Quantitative risk assessment on Umka landslide near Belgrade”, PhD Dissertation, University of Belgrade, Faculty of Mining and Geology, 254pp.
- Abolmasov B., Đurić U. 2021. Results of comprehensive monitoring activities on Umka landslide, Belgrade, Serbia. EUROENGE0 2021, Athens, Greece, 6-10 October 2021, Book of Abstracts.
- Abolmasov B., Đurić U., Popović J., Pejić M., Samardžić Petrović M., Brodić N. (2021) 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. Vol 1,” Sendai Landslide Partnerships and Kyoto Landslide Commitment”, pp.225-234., Print ISBN 978-3-030-60195-9, On-line ISBN 978-3-030-60196-6, © Springer Nature Switzerland AG 2021. [https://doi.org/10.1007/978-3-030-60196-6\\_14](https://doi.org/10.1007/978-3-030-60196-6_14)
- Samardžić Petrović M., Popović J., Đurić U., Abolmasov B., Marjanović M. (2020). Pemanent GNSS monitoring of landslide Umka. Borković A., Malinović M., (eds.): Proceedings of the XIVth International Conference of Contemporary Theory and Practice in Construction, 11-12 June 2020, Banja Luka, Bosnia and Herzegovina. University of Banja Luka, Faculty of Architecture Civil Engineering and Geodesy, 2020, pp 91 - 98. ISSN 2566-4484
- 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
- Đurić U., Marjanović M., Abolmasov B., Radić Z., Jelisavac B. (2018). Building objects and households inventorying for the purpose of risk estimation on the Umka landslide near Belgrade. 17th Serbian Geological Congress, May 17-20, Vrnjačka Banja, Serbia, 668-669 (on Serbian)
- 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
- 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
- Erić V., Božić B., Pejić M., Abolmasov B., Pandžić J. (2017). Permanent geodetic monitoring of the Umka Landslide using GNSS technology and GeoMoss system. Proceedings of 2<sup>nd</sup> Regional Symposium on Landslides in the Adriatic-Balkan Region - 2<sup>nd</sup> 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/>

- Abolmasov, B., Milenković, S., Marjanović, M., Đurić, U., Jelisavac, B. (2015). A geotechnical model of the Umka landslide with reference to landslides in weathered Neogene marls in Serbia. *Landslides* 12 (4): 689-702. DOI 10.1007/s10346-014-0499-4,
- Abolmasov B., Milenković S., Jelisavac B., Đurić U., Marjanović M. (2014). IPL Project 181: Study of Slow Moving Landslide Umka Near Belgrade, Serbia, *Landslide Science for a Safer Geoenvironment* (Eds: Kyoji Sassa, Paolo Canuti, Yueping Yin), Vol.1: The International Programme on Landslides (IPL), Part II, pp 75-80, DOI: 10.1007/978-3-319-04999-1\_5, Print ISBN: 978-3-319-04998-4, Online ISBN: 978-3-319-04999-1, Springer International Publishing.
- Abolmasov B., Milenković S., Jelisavac B., Đurić U., Marjanović M. (2014). Mechanism and Dynamics of Umka Landslide, Belgrade, Serbia, *Landslide Science for a Safer Geoenvironment* (Eds: Kyoji Sassa, Paolo Canuti, Yueping Yin), Vol.1: The International Programme on Landslides (IPL), Part VI, pp 297-302, DOI: 10.1007/978-3-319-04999-1\_41, Print ISBN: 978-3-319-04998-4, Online ISBN: 978-3-319-04999-1, Springer International Publishing.
- Abolmasov B., Pejić M., Šušić V. (2014). The analysis of landslide dynamics based on automated GNSS monitoring. Proceeding of the 1st Regional Symposium on Landslides in the Adriatic-Balkan Region - 1st ReSyLAB 2013, Zagreb 6-9 March 2013. Eds. Sassa K., Mihalić Arbanas S., Arbanas Ž. University of Zagreb, Faculty of Mining, Geology and Petroleum Engineering and University of Rijeka, Faculty for Civil Engineering, Zagreb, Croatia. pp 187-191. ISBN 978-953-6923-26-7, <http://www.klizista-hr.com>
- Abolmasov B., Milenković S., Jelisavac B., Pejić M., Radić Z. (2014). The Analysis of landslide dynamics based on GNSS monitoring-A case study. Proceedings of XII IAEG Congress, Engineering geology for Society and Territory, Vol II, Landslide processes, 15-19 September 2014, Torino, Italy, Springer International Publishing, ISBN 978-3-319-09056-6, pp 143-146.
- Milenković, S., Abolmasov, B., Jelisavac, B., Vujanić, V. (2012). Landslide Umka – The first GNSS monitoring project in Serbia. VII International Symposium-Contemporary theory and practice in building development, Institute for Construction Banja Luka, 26-27 April 2012, Ed. Ačić M., 311-320. ISBN 978-99955-630-7-3.
- Abolmasov, B., Milenković, S., Jelisavac, B., Vujanić, V., Pejić, M., Pejović, M. (2012). Using GNSS sensors in real time monitoring of slow moving landslides-a case study. *Landslides and Engineered Slopes: Protecting Society through Improved Understanding – Eberhardt et al. (eds). Proceedings of the 11th International and 2nd American Symposium on Landslides and Engineered Slopes, Banff, Canada, 3-8 June, 2012. Taylor&Francis Group, London, 1381-1385. ISBN 978-0-415-62123-6*