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

1. **Name of Organization**: The Japan Landslide Society and National Building Research Organisation, Sri Lanka

2. **Name of Leader**: Katsuo Sasahara

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Core members of the activities:

Kithsiri N. Bandara: National Building Research Organization (NBRO), Sri Lanka

Shiho Asano: Forestry and Forest Products Research Institute (FFPRI), Japan

Ryosuke Uzuoka: Disaster Prevention Research Institute (DPRI), Kyoto University, Japan

3. **Date of Submission of Application:** 31/10/2019

4. **Activity scale and targeted region:** Asia

5. **Short Title**: Research on landslide initiation mechanism based on physical model

6. **Objectives for the initial 3 years**:

It is very important for establish an evacuation alert against landslides to know the mechanism of on onset of a landslide. Following themes will be examined to reveal the mechanism of an initiation of rainfall-induced landslide in order to establish the evacuation alert for rainfall-induced landslide in humid Asia regions.

1) Physical model test: to observe the relationship between the deformation and the soil water condition in a model slope under artificial rainfall.
2) Field monitoring: to observe the condition of an initiation of a rainfall-induced landslide by field monitoring of soil water condition and movement of actual landslides.
3) Numerical modelling: to simulate the process of an onset of a rainfall-induced landslide by numerical model.

4) Evacuation alert against rainfall-induced landslide: to establish prediction method of an onset of a rainfall-induced landslide and evacuation alert against a rainfall-induced landslide in humid Asian countries.

7. Background Justification:

Early warning system against rainfall-induced landslides are strongly required to prepare for evacuation against landslides in rainy area in the world. It is needed especially in the area where structural measures cannot be conducted due to insufficient budget. Reasonable criteria should be established to judge the timing of evacuation based on the monitoring of rainfall, soil water condition or deformation in a slope for early warning system. It is the basis for the establishment of the criteria for evacuation against landslides to know the mechanism of an onset of a rainfall-induced landslide.

Mechanism of a rainfall-induced landslide will be examined by physical model test, field monitoring of actual landslides and numerical modeling to establish the model for the prediction of a rainfall-induced landslide in this project. Procedure to establish the criteria for evacuation against rainfall-induced landslides will be attained based on the examination.

8. Resources available for WCoE activities:

Each member will implement his activity for this project by his own budget and his facilities with his fellows in his institute because the activity is a part of the research in his institute. Some part of the activities will be supported by the budget of SATREPS (Science and Technology Research Partnership for Sustainable Development, Japan Science and Technology Agency and Japan International Cooperation Agency) which is named as “Development of Early Warning Technology of Rain-Induced Rapid and Long-Travelling Landslides (2019 – 2023)”. Leaded by Prof. Kazuo Konagai (ICL).
Major facilities in each institute are listed up as below.

(Kochi University)
Model flumes with several sizes
Small-scale slope model apparatus with rainfall infiltration
(FFPRI)
Monitoring equipment for geological, hydrological and metrological characteristics of landslides
Rainfall simulator
Geotechnical testing equipment
(Kyoto University)

Geotechnical test equipment including dynamic triaxial compression test apparatus

Numerical codes for unsaturated ground behavior

Dynamic centrifuge facility with rainfall simulator

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

Prof. Sasahara have been conducted the field monitoring of soil water and deformation in natural slopes and the model slope experiments to monitor the soil water and deformation in the model. Field monitoring at Hiroshima and Kumamoto after large-scale earthquake revealed that shear deformation of the soil layer occurred not only with the decrease of suction (wetting process) but also with the increase of suction (drying process). He examined the relationship between soil water condition and deformation in the model slope and proposed time-prediction method based on the relationship between the shear strain (or surface displacement) and the pore pressure (or groundwater level) in the slope. Influence of repeated rainfalls to the deformation of model slope was also observed in the model slope experiment under artificial rainfalls. In FFPRI, the many research projects related to the mechanism and prevention method of landslides in hilly and forestry regions has been conducted. In Dr. Asano's works, the landslide monitoring system for early warning was developed for the landslide triggered by heavy rain in Vietnam. The mechanism and effect of drainage works of the large-scale landslide triggered by snow melting based on observed hydrological characteristics was clarified. The topological effect of landslide triggered by large-scale earthquake was clarified using numerical analysis. Soil erosion and sediment flow characteristics on slope in volcano and environmental changing by tree cutting in forested mountainous slope has been studied by him.

Prof. Ryosuke Uzuoka has been conducting physical and numerical modeling of multi-phase coupled problems such as unsaturated soil mechanics. His research uses finite element modelling as well as experimental techniques including centrifuge modeling. He has been applying these techniques to study soil liquefaction, slope failure, embankment failure and soil-structure seismic interaction. Recently he applied the numerical method to simulate some landslide cases in Taiwan under collaborative researches with Taiwanese researchers.

10. Planned future activities /Expected Results

Physical model test will be implemented in Kochi University in cooperation with NBRO under the umbrella of SATREPS to examine the influence of rainfall condition, soil water condition in the slope and the deformation and failure. It will produce the procedure for time prediction of rain-induced landslides to establish early warning system against rain-induced landslide based on the monitoring of soil water and

deformation of the slope in cooperation with the activities for field monitoring of landslides in this project. Numerical model for simulating the occurrence and motion of rain-induced landslides will be developed in Kyoto University in cooperation with NBRO. It will be transferred to NBRO in SATREPS Project. It will produce the prediction method of devastated area due to the movement of rain-induced landslides and contributes to the hazard zoning against landslides.

Based on the activities as explained above, prediction method of an onset of a rainfall-induced landslide will be improved and evacuation alert against a rainfall-induced landslide will be more sophisticated based on the results of the activities.

11. Beneficiaries of WCoE

+ Local people in vulnerable area for landslides in humid Asia region
+ Department of civil engineering and forest engineering in central and local government in Japan and Sri Lanka.
+ Japan Science and Technology Agency and Japan International Cooperation Agency.
+ Japanese Landslide Society and Japan Geotechnical Society

12. References

(Katsuo Sasahara)

1) Katsuo Sasahara, Naoki Sakai: Development of shear deformation due to the increase of pore pressure in a sandy model slope during rainfall, Engineering Geology (2013), doi: 10.1016/j-enggeo.2013.12.005

2) Katsuo Sasahara: Prediction of the shear deformation of a sandy model slope generated by rainfall based on the shear strain and the pore pressure in the slope, Engineering Geology 224, pp.75-86, 2017. http://dx.doi.org/10.1016/j.enggeo.2017.05.003

3) Katsuo Sasahara, Naoki Sakai: Shear and compression strain development in sandy model slope under repeated rainfall, Soils and Foundations 57, pp.920-934, 2017. https://doi.org/10.1016/j.sandf.2017.08.021

(Shiho Asano)

1) Shiho Asano: The effect of groundwater drainage positioning on the 3D slope stability of a large-scale landslide, Landslides and Engineered slopes: Protecting society through improved understanding 2 1973-1976, 2012
2) Shiho Asano, Hirotaka Ochiai, Yasuhiko Okada: Observations on earthquake acceleration and pore water pressure in a hilly region, Earthquake-Induced landslides, 863-869, 2012
3) Shiho Asano: Effect of the thickness of geological strata on seismically-induced slope failure in

IMN Earthquake, 2008 in Japan, Landslide Science and Practice, 5, 255-259, 2013

(Ryosuke Uzuoka)

1) Lin, C-H., Hung, C., Weng, M-C., Lin, M-L., Uzuoka, R.: Failure mechanism of a mudstone slope embedded with steep anti-dip layered sandstones: case of the 2016 Yanchao catastrophic landslide in Taiwan, Landslides, 2019. (https://doi.org/10.1007/s10346-019-01250-3)
2) Yang, K-H., Uzuoka, R., Thuo, J.N., Lin, G-L., Nakai, Y.: Coupled hydro-mechanical analysis of two unstable unsaturated slopes subject to rainfall infiltration, Engineering Geology, 216, 13-30, 2017.1 (doi:10.1016/j.enggeo.2016.11.006)
3) Matsumaru, T., Uzuoka, R.: Three-Phase Seepage-Deformation Coupled Analysis about Unsaturated Embankment Damaged by Earthquake, International Journal of Geomechanics, 16(5), C4016006-1-12, 2016.9 (doi:10.1061/(ASCE)GM.1943-5622.0000699)

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.

(None)