Date of Submission	Mar 29th, 2021

IPL Project (IPL - 230) Annual Report Form 2020

1 January 2019 to 31 December 2020

1. Project Number (approved year) and Title

   IPL-244 (2019) Title: Evolution mechanism and control of landslides induced by sudden rainstorm.

2. Main Project Fields

   Hazard Mapping, Vulnerability and Risk Assessment; Catastrophic Landslides; Mitigation

3. Name of Project leader: Prof. Huiming Tang

   Affiliation: Vice President, China University of Geosciences (Wuhan), China.
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   Core members of the Project: Names/Affiliations: (4 individuals maximum)
   Prof. Changdong Li/ Faculty of Engineering, China University of Geosciences (Wuhan), China.
   Dr. Yunfeng Ge/ Faculty of Engineering, China University of Geosciences (Wuhan), China.
   Dr. Jiaqing Zhou/ Faculty of Engineering, China University of Geosciences (Wuhan), China.
   Mr. Wenqiang Chen/ Faculty of Engineering, China University of Geosciences (Wuhan), China.

4. Objectives: (5 lines maximum)

   The objectives of this project are to: 1) establish geological and meteorological coupled model for the analysis of sudden rainstorm-induced landslide; 2) investigate the threshold level of rainfall for sudden rainstorm-induced landslide; 3) reveal the formation and evolution mechanisms of sudden rainstorm-induced landslide.

5. Study Area: (2 lines maximum)

   Baijiabao landslide, one of the most representative sudden rainstorm-induced landslides in the Three Gorges Reservoir area, China.

6. Project Duration (1 line maximum)

   2019 - 2022, 36 months.

7. Report

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

Spatiotemporal deformation characteristics of the reservoir landslide (Baijiabao landslide) were investigated under sudden rainstorm and periodic reservoir water level conditions. A long period monitoring data was collected and analyzed, including GPS surface displacement, deep displacement via inclinometer, rainfall amount and reservoir water level. It turned out that all GPS and AGPS sites displayed similar, step-like displacement trends, a shape that contrasted with the pulse-like annual trends of precipitation and reservoir water level. A sharp increase in the rate of displacement generally occurred from April to August each year, which coincided with the rainy season. The attribute reduction algorithm based on the neighborhood rough set theory was used to identify the important triggering factors controlling the movement of the Baijiabao landslide. It was found the cumulative rainfall during the current month was the most important factor governing the surface movement of Baijiabao landslide during rainy season, whilst the daily surface movement of Baijiabao landslide was dominated by change

in reservoir water level and rainfall during rainy season.

With consideration of the stratified distribution of soil moisture content above the wetting front in the actual rainfall infiltration process, an improved Green-Ampt rainfall infiltration model (SGA) was developed to establish the coupled geological-meteorological analysis model for sudden rainstorm-induced landslide. Compared to general rainfall infiltration model, results based on SGA model showed that the wetting front moved faster, the landslide stability above the sliding surface decreased faster, and the time of landslide failure along the sliding surface was shorter. It was more consistent with the actual situation to use the SGA infiltration model to evaluate the landslide stability under sudden rainstorm. In addition, a hybrid machine learning algorithm called the Two steps SOM-RF model was proposed to create a regional susceptibility map of rainfall-reservoir induced landslides in Jurassic slide-prone strata of western Hubei Province in the China Three Gorges Reservoir area. The results showed that landslides were mainly situated in low mountainous areas with altitudes below 300 m and plains with slope angles lower than 25°; 80% of the landslides occurred in the moderate rainfall area, with annual average precipitation between 800 mm and 1200 mm, which provided meaningful reference to some extent for determining rainfall threshold of rainstorm-induced landslides.

2) Planned future activities or Statement of completion of the Project (15 lines maximum)

With respect to the future activities, special focus will be paid on the deterioration mechanism of soil and rock mass under the action of periodic reservoir operation and rainfall through detailed multi-scale laboratory experiments. In addition, a multi-field characteristic monitoring system, and physical model experimental device and method for sudden rainstorm-induced landslide will further be developed to reproduce the formation process of rainstorm-induced landslide.

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

The above project related researches not only have expanded the understanding of evolution characteristics of rainstorm-induced reservoir landslides, but help to identify triggering factors of the deformation of reservoir landslide. Moreover, the proposed stability evaluation model for rainstorm-induced landslides and mapping method of regional susceptibility for rainfall-reservoir induced landslides could be implemented by technical/scientific agencies for the prevention and control of rainstorm-induced landslides in reservoir area, and thus provide guarantee for the sustainable development of society and economy of the regions threatened by rainstorm-induced landslides.

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

① Yao Wenmin, **Li Changdong***, Zhan Hongbin, Zeng Jiangbo. Time-dependent slope stability during intense rainfall with stratified soil water content. Bulletin of Engineering Geology and the Environment, 2019, 78(7):4805–4819.

② Xiong Shuang, Yao Wenmin, **Li Changdong***. Stability evaluation of multilayer slopes considering runoff in the saturated zone under rainfall. European Journal of Environmental and Civil Engineering, 2019, online. (DOI: 10.1080/19648189.2019.1600038)

③ Long Jingjing, Liu Yong, **Li Changdong**, Fu Zhiyong, Zhang Haikuan. A novel model for regional susceptibility mapping of rainfall-reservoir induced landslides in Jurassic slide-prone strata of western Hubei Province, Three Gorges Reservoir area. Stochastic environmental research and risk assessment, 2020, online. (DOI: 10.1007/s00477-020-01892-z)

④ Yao Wenmin, **Li Changdong***, Zuo Qingjun, Zhan Hongbin, Criss Robert E. Spatiotemporal deformation characteristics and triggering factors of Baijiabao landslide in Three Gorges Reservoir region, China. Geomorphology, 2019, 343:34–47.

Note:

1) If you will change items 1)-6) from the proposal, please write the revised content in Red.
2) Please fill and submit this form by 30 October 2020 to ICL Network <icl-network@iclhq.org>