Date of Submission	21 May 2017

IPL Project Annual Report Form 2016

1. Project Title: Dynamics of subaerial and submarine megaslides

2. Main Project Fields
   (1) Technology Development
   Development of new high stress ring shear apparatus for 100-1000m deep megaslides.
   Monitoring and Early Warning, Vulnerability and Risk Assessment,
   (2) Targeted Landslides: Mechanisms and Impacts
   Catastrophic Landslides, Coastal and Marine Landslides
   (4) Mitigation, Preparedness and Recovery
   Preparedness and Mitigation

3. Name of Project leader
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Core members of the Project
Kazuo Konagai, Yokohama National University, Japan
Ikuo Towhata, University of Tokyo, Faculty of Engineering, Japan
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Farrokh Nadim, NGI, Norway
Alexander Strom, Institute of Geospheres Dynamics of Russian Academy of Sciences
Roger Urgeles, Institute of Marine Sciences, Spanish National Research Council, Spain.

4. Objectives: (5 lines maximum)
Mega landslides of 100-1000 m in depth, greater than 10 million m3 in volume causes a great effect either on land, coastal or under water. Magaslides may trigger Tsunami, landslide dams which may fail and cause great debris flows or floods as well as causing direct damages. So far dynamics of such megaslides has not been studied. This project will develop a super high stress ring shear apparatus of 10 MPa for 100-1000 m deep landslides. The ring shear test results are combined to the Mutibeam Swath Bathymetry, InSAR, GPS on-land and sea floor investigation, combined to 50 Centrifuge model experiment for landslide triggered tsunami, and computer

simulation. It aims to establish Dynamics of Subaerial and Submarine megaslides which may provide reliable risk analysis of ongoing and also potential megaslides over the world.

Study Area: (2 lines maximum)

Japan, Pakistan, Uzbekistan, Norway, Italy, Central Asia, Mediterranean Sea, Viet Nam

5. Project Duration (1 line maximum)

5 years: January 2010 – March 2018

6. Report

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

The project group has developed a new high stress ring shear apparatus (ICL-2) to simulate the initiation and motion of megaslides with more than 100 m depth in 2012-2013. The successful undrained capacity of ICL-2 is 3 MPa. This apparatus was applied to interpret the initiation and motion of the 1792 Unzen Mayuyama megaslide (volume is 3.4 x 10^8 m3, Maximum depth is 400 m) triggered by an earthquake. This landslide killed around 15,000 people by the landslide and the Tsunami wave induced by the landslide. Samples were taken from the source area for initiation and the moving area for motion. The hazard area was estimated by the undrained ring shear tests and the integrated computer simulation model (LS-RAPID, Sassa et al 2010) using parameters obtained from the tests data. The simulation result well matched the real motion of landslides. This test results were orally presented in the Third World Landslide Forum in Beijing, China in June, 2014 (1) and also the XII International IAEG Congress, Torino (2) and published in those proceedings. Through the revision, this research was published in Vol.11, No.5 in 2014 (3).

In 2015, the group has developed a new software to simulate a landslide-induced tsunami (LS-Tsunami). The trigger of tsunami is the moving landslide simulated by LS-RAPID. Landslide mass on the sea floor upheaves sea water which cause tsunami wave. The LS-tsunami was applied to the tsunami induced by 1792 Unzen Mayuyama megaslide. The simulated tsunami heights were close to the historical records in the opposite bank of Ariake Sea.

This paper was contributed to Landslides in 9 January 2016. It was published in December 2016 (Landslides Vol.13, No.6: 1405-1419). This technology was applied to the Haivan Station Landslide which is in the precursor stage in Vietnam and also an earthquake-induced landslide in Kumamoto Prefecture.

Kyoji Sassa and Khang Dang (2017): Landslide Dynamics for Risk Assessment. Landslide Dynamics: ISDR-ICL Landslide Interactive Teaching Tools. Vol.1 Fundamental, Mapping and Monitoring. Springer, under press.

Lam Huu Quang, Doan Huy Loi, Kyoji Sassa, Khang Dang, et al (2017) Susceptibility assessment of a precursor stage of landslide threatening the Haivan Railway Station in Vietnam. It was contributed to Landslides and under revision.

Khang Dang, Kyoji Sassa et al (2016) Mechanism of two rapid and long-runout landslides in the 16 April 2016 Kumamoto earthquake using a ring-shear apparatus and computer simulation (LS-

RAPID) Landslides, Vol.13, No.6: 1525–1534

Khang Dang, Kyoji Sassa (2016) Simulation of landslide initiation and motion based on the measured parameters of soils taken from Unzen-Mayuyama landslide in Japan. Proceedings of the Final SATREPS Workshop on Landslides,13 October 2016, Hanoi, Vietnam, pp 86-97.

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

This year in 2017, we intend to write a manual of this LS-RAPID and LS-Tsunami in the planned ISDR-ICL Landslide Interactive Tools “Landslide Dynamics”. The group will support other ICL members to apply this methods to landslides and landslide induced tsunami in other countries.

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

Megaslides either on land and submarine bed are posing a great risk because of its scale.

Submarine landslides causes Tsunami. Global communities that are exposed to risk by subaerial

and submarine megaslides, policy-makers, public administrators, researchers, scientists are beneficiaries of this project.

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

1. Sassa K, He B, Dang KQ, Nagai O (2014) Plenary: Progress in Landslide Dynamics. Landslide Science for a Safer Geoenvironment, Proc. The Third World Landslide Forum, Springer, Vol. 1: 37-67
2. Kyoji Sassa (2014) Landslide Risk Assessment at Cultural Heritage. Keynote for XII International IAEG Congress, Torino, Engineering Geology for Society and Territory (eds: Giorgio Lollino etc) , Vol.2 Landslide Process :79-103
3. Kyoji Sassa, Khang Quang Dang, Bin He, Kaoru Takara, Kimio Inoue, Osamu Nagai (2014): Development of a new high-stress undrained ring shear apparatus and its application to the 1792 Unzen-Mayuyama megaslide in Japan. Contributed to Landslides. Vol.11, No.5: 827-842
4. Kyoji Sassa, Khang Quang Dang, Hideaki Yanagisawa, Bin He (2016) A new landslide-induced tsunami simulation model and its application to the 1792 Unzen-Mayuyama landslide-and-tsunami disaster, Landslides Vol.13, No.6: 1405-1419.
5. Dang K, Sassa K, Fukuoka H, Sakai N, Sato Y, Takara K, Lam H Q, Doan H L, Pham V T, Nguyen D H (2016) Mechanism of two rapid and long runout landslides in the 16 April 2016 Kumamoto earthquake using a ring-shear apparatus and computer simulation (LS-RAPID). Landslides Vol.13 (6): 1525-1534.
6. Doan Huy Loi, Lam Huu Quang, Kyoji Sassa, Kaoru Takara, Khang Dang, Nguyen Kim Thanh, Pham Van Tien (2017) The 28 July 2015 rapid landslide at Ha Long City, Quang Ninh, Vietnam Landslides (published online first：DOI: 10.1007/s10346-017-0814-y)