Date of Submission	1 Feb. 2016

IPL Project Annual Report Form 2015

1 January 2015 to 31 December 2015

1. Project Title

   Development of a methodology for risk assessment of the earthquake-induced landslides

2. Main Project Fields

   Technology Development: Hazard Mapping, Vulnerability and Risk Assessment

   Targeted Landslides: Catastrophic Landslides

   Preparedness

3. Name of Project leader

   Satoshi Tsuchiya (Shizuoka University)

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   Core members of the Project: Names/Affiliations: (4 individuals maximum)

   Hiroshi Yagi (Yamagata University)

   Akihiko Wakai (Gunma University)

   Daisuke Higaki (Hirosaki University)

4. Objectives: (5 lines maximum)

   To clarify the mechanism of the earthquake-induced landslides on the basis of surveying types, dimensions, distributions and run-out distances of the landslides and analyzing relations to the seismicity and geology. Finally, to make up appropriate technical guidelines for risk assessment of earthquake-induced landslides.

5. Study Area: (2 lines maximum)

Asian-Pacific Region (especially in Asian Orogenic Zone)

6. Project Duration (1 line maximum)

Three years

7. Report

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

The Japan Landslide Society in collaboration with Ministry of Land, Infrastructure Transportation and Tourism (MLIT) has proposed the AHP hazard zonation methods of the earthquake-induced landslides as the technical guideline in Japan for hazard zonation of earthquake-induced landslides by the Japan Landslide Society in 2014 based on the analysis of case histories of past earthquake disasters (Higaki, et al, 2015; Hayashi et al, 2015; Hamasaki et al, 2015; Sato et al, 2015). Trial studies on application of the technical guideline have been initiated in some high-risk areas of the Nankai Trough mega earthquake in order to adopt the guideline to landslide disaster management at the government basis in January 2015.

The study areas are the mountains consisting of the Paleogene accretionary complex in Kochi and Shizuoka Pref. and hills of Miocene sedimentary and volcanic rocks in Shizuoka Pref. along the Pacific Ocean. Relief energy and complexity of slopes of a certain scale are pointed out to be important topographic factors of AHP hazard mapping of large-scale deep-seated landslides which have been triggered by past trench earthquakes due to complex geological structure. It is proposed that the weight value of relief energy class can be decided by analyzing frequency distribution of each relief class in the target area to get appropriate AHP score for evaluation of hazard level.

Hazard levels of coherent landslides are also evaluated in Miocene sedimentary rocks and volcanic rocks located in the west side of Fossa Magna by adopting the AHP hazard zoning model developed based on landslides in mudstone and tuffecious rocks by the 2004 Mid-Niigata Earthquake and the 2008 Iwate-Miyagi Nairiku Earthquake. Slopes formed by large-scale coherent landslides are evaluated as high AHP scores. Detection of landslide-susceptible slopes by seismic response analysis based on elasto-plastic finite element method is also performed as more detailed scale hazard mapping.

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

Based on further verification of the proposed AHP models for landslide hazard mapping for recent earthquake-induced landslide cases such as in the area of Miocene and Pliocene sedimentary rocks of the Nagano-ken Hokubu Earthquake in 2011 and 2014. The landslides

cases of Nepal Gorkha Earthquake in 2015 for which the research groups of international geo-hazard response performed landslide mapping by satellite images may also be an important target of verification. This method is expected to be used by local governments for earthquake disaster management within a few years. The Japan Landslide Society is also planning publications of the research results mentioned above on international academic journals.

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

The Asian-Pacific Region has been seriously threatened by the earthquake-induced landslides. The rapid growth of the population and development of infrastructure of this area have led to an extreme high vulnerability to landslide disasters caused by earthquakes. The methodology for hazard zonation will be able to support scientists and engineers as well as decision makers working in the field of hazard management. Inhabitants of the whole countries in the Asian-Pacific Region can also be beneficiaries of this project who intend to assess vulnerability of their lands to earthquakes.

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

Several papers have been recently published on the Journal of the Japan Landslide Society, though they are in Japanese with English abstract.

Hayashi, K., Hamasaki,H., Yagi, H., and D. Higaki (2015) Development of landslide susceptibility mapping model for earthquake-induced landslides baed on buffer movement analysis and blunder probability analysis, Journal of the Japan Landslide Society, 52-2, 60-66.

Higaki, D., Hayashi, K., Hamasaki E., The project team of Collaborative Research for River and Erosion Control, Japan Landslide Society(2015) A report on Collaborative Research for River and Erosion Control,by Japan Landslide Society and MLIT=Susceptibility mapping of earthquake-induced landslides, 52-2, 37-44.

Higaki, D., Tsuchiya, T., Niinuma, T. and N. Chiba (2014) Landslides in the area around Matsushima Bay caused by the Pacific Ocean Earthquake off Tohoku region in 2011, Proc. of World Landslide Forum 3, Vol.4, 512-517 , Beijing, (2014)

Wakai, A., Cai, F., Ugai, K. and Soda, T.(2014) Finite element simulation for an earthquake-induced catastrophic landslide considering strain- softening characteristics of sensitive clays, Landslide Science for a Safer Geoenvironment, Proc. World Landslide Forum 3, Vol.2, pp.275-280, Beijing.

Wakai, A., Cai, F., Ugai, K. and Soda, T. (2014): Numerical simulation for an earthquake-induced catastrophic landslide considering strain-softening characteristics of sensitive clays, Proc. IAEG XII Congress, S2.9, Torino, (2014)

Wakai, A., Cai, F., Ugai, K. and Soda, T. (2014) Finite element simulation for an earthquake-induced landslide considering strain-softening characteristics of sensitive clays, Proc. Computer Methods and Recent Advances in Geomechanics, p.242, Kyoto.