Landslides, GeoParks, and World Heritages

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1. Landslides in areas of high societal values

Landslides are the most typical hazardous phenomena which give fatal and societal impacts. Most recent serious disastrous landslides in Japan, took place in Hiroshima in August 2014 and in Izu-Oshima, a volcanic island of Tokyo. Hiroshima case claimed 74 casualties and Izu-Oshima claimed 39. Both disasters were induced by extreme rains, recording large return period. Both of the landslide hit areas are newly developed residential sites expanding to hillside slopes, which generally attracts people by good view and but places higher risk to residents.

2. GeoParks and World Heritages at landslide risk

UNESCO World Heritage Center has inscribed many natural and cultural sites in its World Heritages list. Most important factor of World Heritage definition is the "irreplaceable" value for mankind. UNESCO also launched GeoPark programme and creating Global GeoPark Network (UNESCO, 2014). Definition of Geopark is specific heritage sites of international and geological significance. Many of municipal or national governments which manage Geoparks are keen to promote awareness and education of geological hazards, such as landslides, earthquakes, volcanic eruption.

UNESCO-IUGS (International Union of Geological Sciences) joint programme IGCP (International Geological Correlation Programme) No. 425 on "Landslide hazard assessment and mitigation for cultural heritage sites and other locations of high societal value" was organized in 1998-2002 to promote international joint research on this topic. More than 20 joint projects were proposed and launched. This activity contributed to the establishment of the International Consortium on Landslides (ICL) which consists of about 60 organizations now and coordinates international research and education projects. It operates the International Programme on Landslides (IPL) which is supported by 5 UN agencies (UNESCO, FAO, WMO, UNISDR, and UNU).

3. Landslide risk reduction through assessment and monitoring

The author have been involved in research projects on landslide risk at Machu Picchu (Peru, World Heritage site) (Sassa, 2014, Sassa, et al., 2008), Lishan mountain

(China, national cultural heritage site) (Fukuoka et al., 2005), Unzen volcano (Japan, World GeoPark site) (Sassa, 2014), Zentoku landslide of Iya valley (Tokushima, Japan, cultural heritage site), as well as above-mentioned Izu-Oshima recent landslide disaster site (Japan, national GeoPark site). In Niigata prefecture, we have Itoigawa national GeoPark site which has a landslide disaster site which took place decades ago.

3.1 Mechanical approach

In the case of recent Izu-Oshima landslide case, author has conducted undrained and stress-controlled ring shear tests to prove that the high mobility of the event came from the generation of high excess pore pressure to reduce the effective stress, and thus the shear resistance dropped largely. The major cause of the pore pressure generation was grain crushing of the volcanic ash deposits on the hill slope surface. These phenomena are called as "Sliding surface liquefaction." (Sassa, Fukuoka, et al., 2007)

3.2 Monitoring approach

In the case of international joint research on Machu Picchu, researchers from Japan, Italy, Canada, and Czech Republic joined and contributed / installed various sensors on the slope. Japanese team installed short-span and long-span extensometers and found small displacement which corresponded to rainfall. According to geomorphic interpretation of the airphotos, this site had been subjected to large-scale ancient rock slides, and the current World Heritage site was apparently at landslide risk possibly caused by future earthquake because the site is located on crossing of two fault system. Interim report of our study gave great impact to Peruvian society and we learned that dissemination of scientific research on risks at heritage sites required careful consideration.

References

UNESCO (2014): (Guidelines and Criteria for National Geoparks seeking UNESCO's assistance to join the Global Geoparks Network (GGN). http://www.globalgeopark.org/UploadFiles/2012_9_6/Geoparks_Guidelines_Jan2014.pdf

Sassa, K. (2014): Landslide Risk Assessment at Cultural Heritage Sites. IAEG . In: Lollino, et al. eds., Engineering Geolgoy for Society and Territory, Vol. 2, pp.79-103.

Sassa, K., Fukuoka, H., Carreno, R. (2008) Landslide investigation and capacity building in the Machu Picchu-Aguas Calientes Area (IPLC101-1). In: Sassa and Canuti (eds) Landslides-disaster reduction, Springer, pp 229–48

Sassa, K., Fukuoka, H., Wang, G., Wang, F. (eds.) (2007): Progress in Landslide Science, Springer Verlag, 378 pages. ISBN-10: 3540709649

Fukuoka, H., Sassa, K., Wang, G., Wang, F., Wang, Y., Tian, Y. (2005): Landslide Risk Assessment and Disaster Management in the Imperial Resort Palace of Lishan, Xian, China (C101-4). Landslides - Risk Analysis and Sustaibale Disaster Management (eds. K. Sassa, H. Fukuoka, G. Wang, F. Wang), (Springer Verlag), pp. 81 – 89.