Geophysical Research Abstracts
Vol. 13, EGU2011-1478, 2011
EGU General Assembly 2011

The impact of increasing rainfall on landslide slope stability in Kyushu district, Japan

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1. Objective
Increase in rainfall that may be induced by the global climate change is obvious in Kyushu district, Japan, according to the analysis of rain data observed in various locations including mountainside points that are not influenced by local warming due to urbanization. On this point of view, we are intrigued to elucidate the response of landslide to this increase in rainfall. Hence, its long term impact on the specific landslide slopes in this area is analyzed using numerical simulation method i.e. finite element method in order to evaluate the landslide slope stability in the future.
2. Method and target areas
Field investigation on landslides slopes and slope failures are conducted to obtain the geologic data, geo-structure, vegetation feature, soil samples and topographic data i.e. cross sections, then soil shear tests and soil permeability tests are also conducted. The rainfall data at the nearest rain observatory were obtained from the database of Japan meteorological agency. The long term impact on the slope stability in the area is analyzed by the finite element method (FEM) combined with rain infiltration and seepage analysis with the long term rainfall fluctuation data, obtaining factor of safety (Fs) on real landslide slopes.
The target areas are located in northern Kyushu district, western Japan where they often have severe landslide disasters. For the FEM analysis, four landslide slopes are selected from ones that occurred due to heavy rainfall caused by stationary front in July 2009 and 2010. The geology in research areas consists of Paleozoic and Mesozoic rocks (mainly schist, slate, serpentine) and the vegetation consists of mainly Japanese cypress, cedar or bamboo.
3. Result and consideration
Consequently, the long term rainfall increase in the region such as increment of approximately 20mm/hr for rain intensity Ri, or 50mm/day for daily rain Rd in 40 years is confirmed statistically using Kendall's rank correlation, and it is found that its impact on slope stability is oblivious and critical. In the sample landslide slopes, even the increase in rain of duration for only 10 years has severe impact on their stabilities in terms of Fs. The Fs calculated with rains in previous decade is higher than 1.0 such as 1.05 that corresponds to stable state, whereas the Fs with present rains is lower than 1.0 such as 0.98 which means unstable state.
4. Conclusion
The increase of rainfall Ri, Rd due to climate change with the increasing rate such as 20mm/hr or 50mm/day in 40 years surely has strong impact on almost landslide slopes in aspects of slope stability. Therefore, with this rain increase rate, it is possible for many forest slopes or natural slopes to become unstable and cause landslide disasters.