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. On this point of view, its long term impact on the specific landslide slopes in this area is analyzed using numerical simulation method i.e. finite element method to evaluate the landslide slope stability in the future.

2. Method and target areas

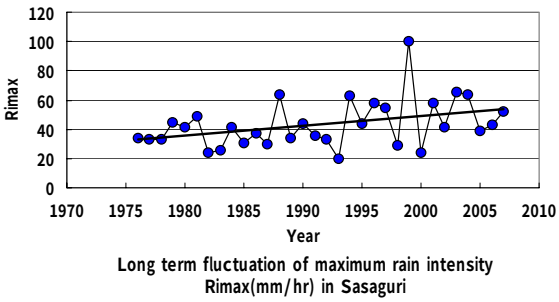
The target areas are located in northern Kyushu district, western Japan where they often have severe landslide disasters. For the FEM analysis, four landslide slopes are selected from ones that occurred due to heavy rainfall caused by stationary front in July 2009 and 2010. The geology in research areas consists of Paleozoic and Mesozoic rocks (mainly schist, slate, serpentine).

3. Result and consideration

Consequently, the long term rainfall increase in the region such as increment of approximately 20mm/hr in rain intensity Ri, or 50mm/day in daily rain Rd in40 years is confirmed statistically using Kendall's rank correlation, and it is found that impact on slope stability obvious and critical.

Fig.1 Sasaguri and Fukuchi landslides in 2009

Fig.2 Keisen landslide in 2010



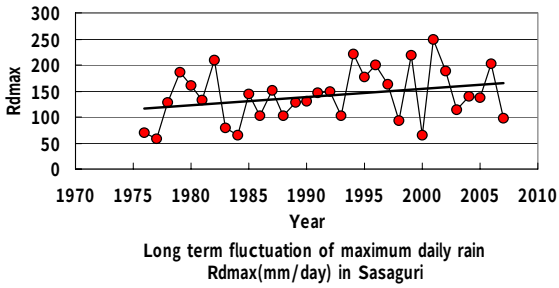


Fig.3 Rainfall increase in Sasaguri area

4. Conclusion

The increase of rainfall due to climate change has strong impact on almost landslide slopes in aspects of slope stability.

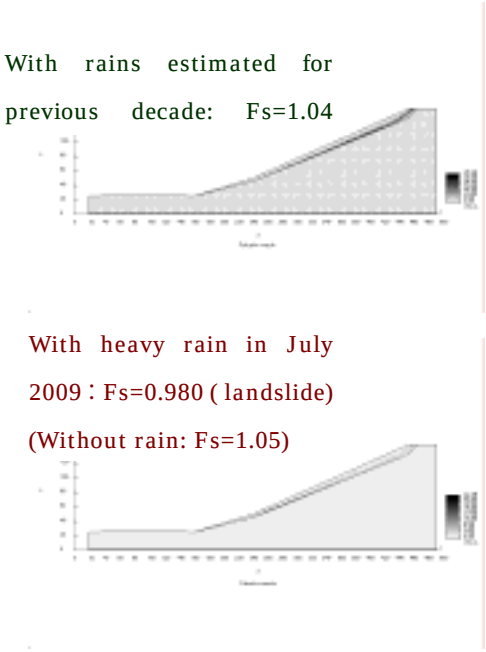


Fig.5 The slope stability analysis results in Fukuchi (Fs=1.04 →0.980)

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 estimated for previous decade is higher than 1.0 such as 1.04, whereas the Fs with present disaster rains is lower than 1.0 such as 0.98.

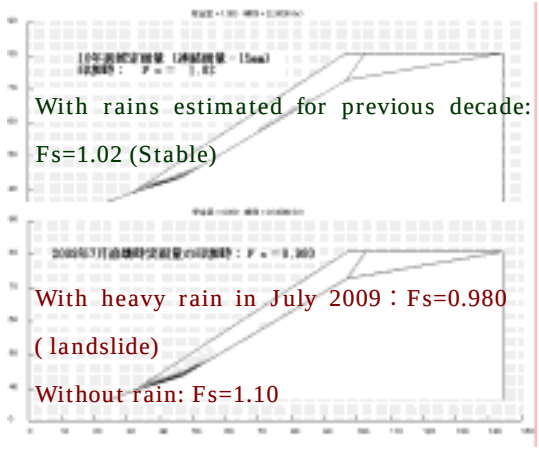
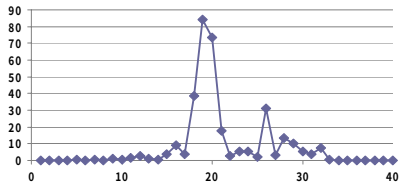
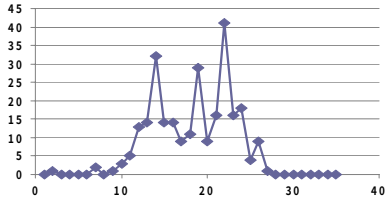


Fig.4 The slope stability analysis results in Sasaguri (Fs=1.02 →0.980)



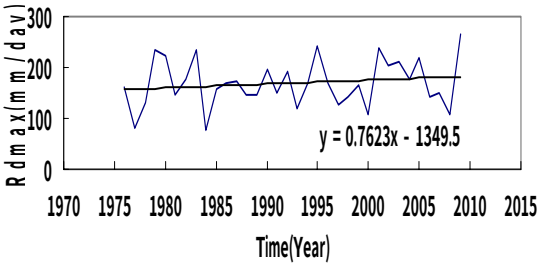
The hyetograph of heavy rain in July 2009 at Sasaguri：Fs=0.98



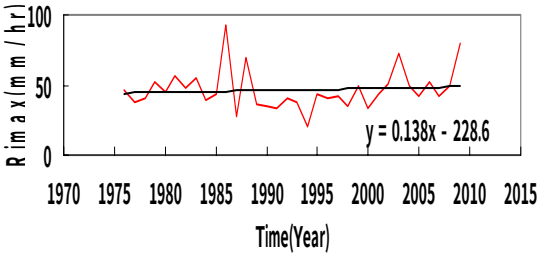
The hyetograph of heavy rain in June 2001：Fs=1.02 (stable)

Fig.6 The examples of rainfall pattern

Additional data and analysis

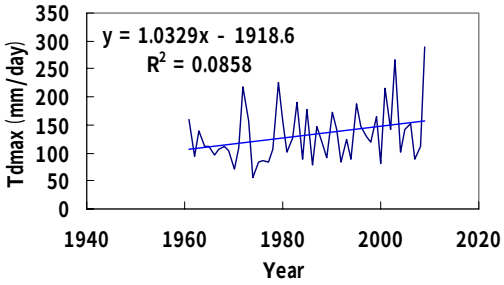


Long term fluctuation of daily maximum rain Rdmax at Kagumeyoshi

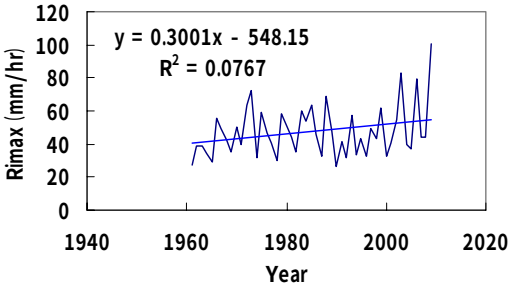


Long term fluctuation of maxumum rain intensity Rimax at Kagumeyoshi

Fig.7 Rainfall increase in Kagumeyoshi observatory for Fukuchi



Maxumun Daily Rainfall Fluctuation in Iizuka



Maximun Rain Intensity Fluctuation in Iizuka

Fig.8 Rainfall increase in Iizuka observatory for Keisen area

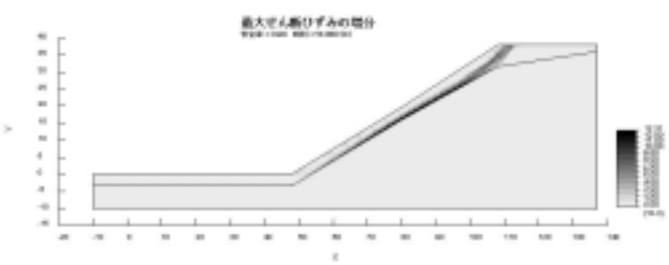


Fig.9 Slope stability analysis for the Landslide in Keisen area in July 2010 and destroyed house by the landslide

Landslide at Keisen induced by heavy rainfall, July 2010

◇ The Fs calculated with estimated rains for previous 3 decade is Fs=1.01 (−9mm/hr).

◇ The Fs calculated with estimated rains for previous decade is Fs = 0.990 (−3mm/hr).

◇ The Fs calculated with estimated uniform rain (8mm/hr) is Fs = 1.08.

(The increment in maximum shear strain is larger than the one without rain stress.)