Geophysical Research Abstracts,
Vol. 11, EGU2009-4069-7, 2009
EGU General Assembly 2009

Characteristic and Behavior of Rainfall Induced Landslides in Java Island, Indonesia : an Overview

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Landslides are important natural hazards occurring on mountainous area situated in the wet tropical climate like in Java, Indonesia. As a central of economic and government activity, Java become the most populated island in Indonesia and is increasing every year. This condition create population more vulnerable to hazard. Java is populated by 120 million inhabitants or equivalent with 60% of Indonesian population in only 6,9% of the total surface of Indonesia. Due to its geological setting, its topographical characteristics, and its climatic characteristics, Java is the most exposed regions to landslide hazard and closely related to several factors: (1) located on a subduction zone, 60% of Java is mountainous, with volcano-tectonic mountain chains and 36 active volcanoes out of the 129 in Indonesia, and these volcanic materials are intensively weathered (2) Java is under a humid tropical climate associated with heavy rainfall during the rainy season from October to April. On top of these “natural” conditions, the human activity is an additional factor of landslide occurrence, driven by a high demographic density

The purpose of this paper was to collect and analyze spatial and temporal data concerning landslide hazard for the period 1981-2007 and to evaluate and analyze the characteristic and the behavior of landslide in Java. The results provides a new insight into our understanding of landslide hazard and characteristic in the humid tropics, and a basis for predicting future landslides and assessing related hazards at a regional scale. An overview of characteristic and behavior of landslides in Java is given. The result of this work would be valuable for decision makers and communities in the frame of future landslide risk reduction programs.

Landslide inventory data was collected from internal database at the different institutions. The result is then georefenced. The temporal changes of landslide activities was done by examining the changes in number and frequency both annual and monthly level during the periods of 1981 – 2007. Simple statistical analysis was done to correlate landslide events, antecedent rainfall during 30 consecutive days and daily rainfall during the landslide day. Analysis the relationship between landslide events and their controlling factors (e.g. slope, geology, geomorphology and landuse) were carried out in GIS environment.

The results show that the slope gradient has a good influence to landslides events. The number of landslides increases significantly from slopes inferior to 10° and from 30° to 40°. However, inverse correlation between landslides events occurs on slope steepness more than 40° when the landslide frequency tends to decline with an increasing of slope angle. The result from landuse analysis shows that most of landslides occur on dryland agriculture, followed by paddy fields and artificial. This data indicates that human activities play an important role on landslide occurrence. Dryland agriculture covers not only the lower part of land, but also reached middle and upper slopes; with terraces agriculture that often accelerate landslide triggering.

During the period 1981-2007, the annual landslide frequency varies significantly, with an average of 49 events per year. Within a year, the number of landslides increases from June to November and decreases significantly from January to July. Statistically, both January and November are the most susceptible months for landslide generation, with respectively nine and seven events on average. This distribution is closely related to the rainfall monthly variations.

Landslides in Java are unevenly distributed. Most landslides are concentrated in West Java Region, followed by Central Java and East Java. The overall landslide density in Java reached 1x10 events/km with the annual average was 3.6 x 10 event/km /year. The amount of annual precipitation is significantly higher in West Java than further East, decreasing with a constant W-E gradient. The minimum annual rainfall occurs in the northern part and in Far East Java, where few landslides can be spotted. Cumulative rainfalls are playing an important role on landslides triggering. Most of shallow landslides can be associated with antecedent rainfall, and rainfall superior on the day of landslide occurrence. There is an inverse relation between antecedent rainfalls and daily rainfall. Indeed heavy instantaneous rainfall can produce a landslide with the help of only low antecedent rainfall. On the contrary we encountered 11 cases of landslides with no rain on the triggering day, but with important antecedent rainfalls.

Key words: rainfall induced landslide, spatio-temporal distribution, Java Island, Tropical Region.