A Method for Predicting and Taking Measures Against Soil Slips Generating Debris Flows in a Case Study of the 2014 Hiroshima Sediment Disasters

Yoshiharu ISHIKAWA[1], Hiroyuki UMEZAWA[1], Risa TANABE[1], Aya TAMEIKE[1*] and Quoc Dung DANG[2]

[1] Toa Grout Kogyo Co., Ltd, Japan
[2] Ton Duc Thang University, Vietnam
*Corresponding author. E-mail: aya.tameike@toa-g.co.jp

INTRODUCTION

According to research by Tsukamoto et al., soil slips that cause debris flows are highly likely to occur in zero-order basins.Tsukamoto et al. defined all depressions seen on mountainside slopes that have not grown into first-order channels as zero-order channels (under-first-order channels), and made it clear that soil slips in zero-order channels are widely distributed. However, if one is to predict the causes of debris flows and consider measures to be taken against them, the area of causes of debris flows must be limited because the scope of prediction of points of soil slips is widely distributed, and cost superiority cannot be maintained. Against such a background, in this paper we have classified the points of soil slips which generate debris flows by geographic feature in consideration of the August 2014 sediment disasters due to heavy rainfall in Hiroshima Prefecture with the aim of predicting the generation of debris flows with high probability, and we have calculated the ratio of such occurrences.

OUTLINE OF THE SEDIMENT DISASTER IN HIROSHIMA

From 3:00 to 4:00 AM on Aug. 20th, maximum hourly rainfall of 101mm occurred in the northwestern part of Hiroshima City, almost at the same time, many soil slips occurred in the headwater of streams around Mt. Abu and Mt. Takamatsu, triggering debris flows. The debris flows flooded on the alluvial fans and caused great injury with 74 fatalities, and great damage, with 133 totally destroyed houses and 297 houses half and partially destroyed. The areas are geologically made up of weathered granite and sedimentary rock.

METHOD

Our research covered two geographic areas, namely Mt. Abu (about 585 meters above sea level) and Mt Takamatsu (about 340 meters above sea level), where debris flows have frequently occurred. The scars of the debris flows are shown in a 1/5,000 contour diagram by using aerial photographs taken after the occurrence of disasters in the areas covered by our research. In conformity to the set definitions, we classified the points of occurrence of soil slips and calculated the ratios thereof. Moreover, we classified the soil slips in zero-order channels into three categories to narrow down the areas to predict and then calculated the ratios thereof (**Figure 1**).

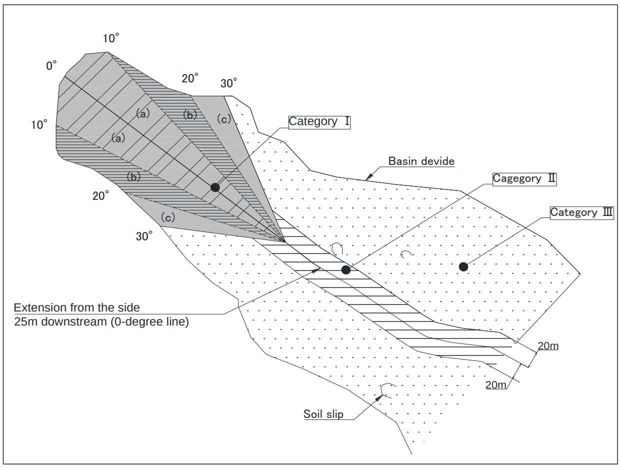

Figure 1. Soil slip point categories

RESULTS

The number of points of soil slips surveyed was 181. According to the classification results, Category I had the highest rate of occurrence, about 53%. Category II had a rate of occurrence of about 10%, while Category III had a rate of occurrence of about 37%. Then, we further sub-classified the Category I collapses. Category I (a) had the highest rate, about 24% (**Figure 2**).

Moreover, the number of existing zero-order channels we read in the overall area was 155, and there were 73 points of zero-order channels that had soil slips. Thus, this value accounted for about 47% of all zero-order channels.

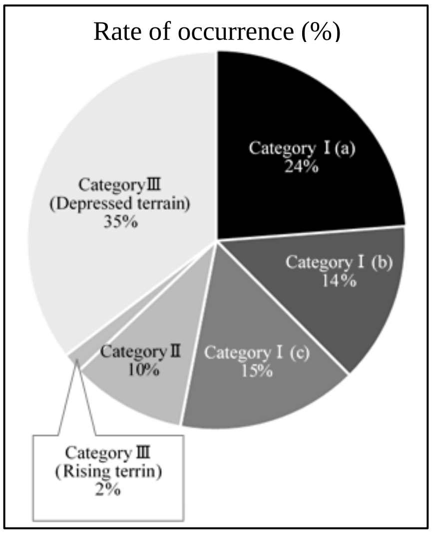

Figure 2. Point of soil slips

CONCLUSION

In the areas surveyed in this research, soil slips occurred in about half of all zero-order channels in the surveyed areas, and most such soil slips developed into debris flows. So, we consider that about half of such debris flows could have been prevented by taking measures against soil slips in zero-order channels. As for which points to take such measures at, we think that the places classified as Category I (a) under Category I are important.

When the areas of Category I (a) in the areas of zero-order channels with high probability of soil slips are small, slope stability works (Photo 1) are suitable for the measures to prevent soil slips which generate debris flows. Whereas, if the areas of Category I (a) are large, flexible debris flow barrier (Photo 2) which catch the debris generated in the areas of zero-order channels located in the headwater of the streams is suitable for the measures, because when the slope stability works are used , the large scale of structures is necessary.

However, as both the number and area of all zero-order channels are enormous, we think it necessary to determine levels of importance by narrowing down the areas to be surveyed based on which mountain streams have the possibility of causing debris flows as well as the presence or absence of measures for mountain streams and their lower reaches that may stop the debris flows.

Photo 1. An example of slope stability works used by high tensile strength steel net.

Photo 2. An example of capture of debris by flexible debris flow barrier.

Keywords : soil slip, debris flow, zero-order channel, slope stability work, flexible debris flow barrier