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Hydrology and Earth System Sciences Discussions

Interactive comment on "Distributed specific sediment yield estimations in Japan attributed to extreme-rainfall-induced slope failures under a changing climate" *by* K. Ono et al.

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We are greatly appreciating the reviewer's comments. Answers for your comments were made after careful consideration of each comment and listed below. Manuscript was revised accordingly.

Comment 1 How are the annual sediment yields estimated? Answer Sediment depth were measured by the automatic sensors (Echo sounding equipment) and used with the available cross-sections of the basin to calculate the annual sediment yields. These data are available for the public use in the data base of Ministry of Land, Infrastructure,

Transport and Tourism (MLIT) in Japan.

Comment 2 Do only slope failures contribute to the sediment yield or are there other sediment sources acting all over the year? Can the mentioned basins be reached directly by slope failures or has the material be transported by subsequent floods? Answer All selected dams in our study are located in the upstream of the rivers, where the catchment area is largely cover with forest. According to Hasegawa et al, (2005) and Japan Nuclear Cycle Development Institute technical report (1999), effect of rainfall on soil erosion in upstream catchments in Japan is minimal. This is because; plant density in Japanese forest is large, which prevent excessive sediment erosion by normal rainfall events. Therefore, the effect of soil erosion on sediment accumulation is quite small compared to large sediment yield produced by slope failures. References Hasegawa K., Wakamatsu K., and Matsuoka M. (2005). Mapping of potential erosion-rate evaluated from reservoir sedimentation in Japan. Journal of Natural Disaster Science, Vol. 24, pp. 287-301. Japan Nuclear Cycle Development Institute technical report (1999), pp. 85-93.

Comment 3 Yearly sediment deposition can only be correlated to yearly rainfall data, the number of extreme rainfall events, the days with rainfall above a chosen threshold etc. Answer According to the Climate Change Monitoring Report (2004), the number of annual average slope failures is high as over 1000 in Japan, where majority of them occurred following heavy rainfall events. Therefore, not all, but higher percentage of accumulated sediment in the dam can be attributed to large quantity of sediment produced by slope failures. Even though, use of many corresponding parameters, such as the number of extreme rainfall events, the days with rainfall above a chosen threshold, would complete the regression model, it make difficult the model use for climate predictions. Therefore, it would be appropriate to consider extreme precipitation of that particular year.

Comment 4 Extreme sedimentation do have a recurrency interval of more than 30 years (30 years means frequent events). Answer We agreed with the reviewer's comment about larger return period in the context of flood simulations or dam design. In this particular study also, we examined the effect of different return periods (5, 10, 15, 20, 25, and 30 years) on sediment yield and found that 5 year return period has the highest correlation with the observed sediment yields (Figure 1). Particular discussion about the selection of 5 year return period among several others can be found in page 7131, Line 23 to page 7132, Line 15.

Comment 5 The climate change scenarios used in this study are unknown outside of Japan. What are the main results of this studies? Answer MRI and MIROC models have been well documented and used in the IPCC AR4 report and many other studies. MRI-RCM20-Ver.2 and MIROC3.2 HIRES were selected due to availability of output in high resolution than the other models. Nevertheless, MIROC and MRI-RCM20-Ver.2 have been proven to be very effective in simulating the climate variables that eventually produced the impacts for extreme cases over wider ranges (GERF S-4 project document, 2008). Therefore, they avoid the extensive downscaling efforts that are necessary for many GCM scenarios for predicting the impacts in a reliable range. Main result of our study is the developed hazard map of sediment yield attributed to extreme-rainfall-induced slope failure under changing climate conditions for all of Japan.

Comment 6 No one can create climate hazard maps for the future! Which hazard will be evaluated? Who will be endangered? Answer There are many studies that they evaluate the climate hazard in the future (e.g. Veijalainen et al., 2010; de Moel et al., 2009). Also, there are many hazards to be evaluated under changing climate conditions. However, evaluation of a particular hazard facilitates us to identify vulnerable areas in the future and lead us to plan mitigation measures beforehand. Estimations of our study do not focused on individuals or the small communities, but narrow downed the large-scale estimations to the basin scale. References Veijalainen N, Lotsari E, Alho P, Vehvilainen B, Kayhko J (2010). National scale assessment of climate change impacts on flooding in Finland. Journal of Hydrology 391, pp. 333–350.

de Moel, H., van Alphen, J., Aerts, J., 2009. Flood maps in Europe – methods, availability and use. Nat. Hazards. Earth Syst. Sci. 9, 289–301.

Comment 7 What does this mean: ...an elevated turbidity concentration of over 100 degrees was recorded....? Answer Japanese standard for turbidity for drinking water is 2 NTU. In this case, it has observed high turbidity concentration which is 50 times higher than the drinking water standard and 10 times higher than the required quality for recreational activities. In this particular case, an elevated turbidity concentration of over 100 degrees was recorded after a series of slope failures following extreme-rainfall events. Therefore, this observation stands as a clear evidence for impacts on water quality.

Comment 8 Why should the annual sediment yield be normally distributed throughout the recording interval when you correlate the probability of slope failure to "extreme" rainfall events? Answer We estimated extreme-rainfall for each year considering 24-hour maximum rainfall data in that particular year. However, it does not mean that the estimated 21 extreme-rainfall values from 1980 to 2000 (1 value per one year) are extremely distributed. Slope failures have been dominated the causes of producing sediment yield. Therefore, our study developed a relationship between extreme rainfall of the year and accumulated sediment yield in the same year.

Comment 9 What does this mean: ...therefore, areas that will cross the lower edge of the rising limb in the future..? Answer According to Fig. 4, the rate of change of the sediment yield (gradient of the curve) is more sensitive to a small change in the hydraulic gradient within the rising limb of the curve For a example, curve for colluvium formations and 30 relief energy, there is no significant change of specific sediment yield for hydraulic gradient change during 0.2 to 0.4 (Please see the attached figure). However, after passing 0.4, curve starts the rising limb where significant sediment yield production can be noticed to small change of hydraulic gradient. Therefore, areas that will cross the lower edge of the rising limb in the future may have a critical impact on the sediment yield under changing climate conditions.

Comment 10 The produced susceptibility map of slope failures is validated? Answer The produced slop failure map has been validated with historical landslide hazard data for Tochio city, where 183 landslides were occurred in 2004 (Please see Kawagoe et al., 2010). It showed that all 183 slope failures have occurred in the areas where we have estimated slope failure probability with more than 80%.

Reference Kawagoe, S., Kazama, S., Sarukkalige, P. R.: Probabilistic modelling of rainfall induced landslide hazard assessment, Hydrol. Earth Syst. Sci., 14, 1047–1061, 2010.

Comment 11 Figures are unclear, mainly because of the scale, but also because of the content (fig.1, 2) Answer It may because of the scale that has printed in the paper. We will try to improve the quality of the paper in the final manuscript.

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 7, 7121, 2010.

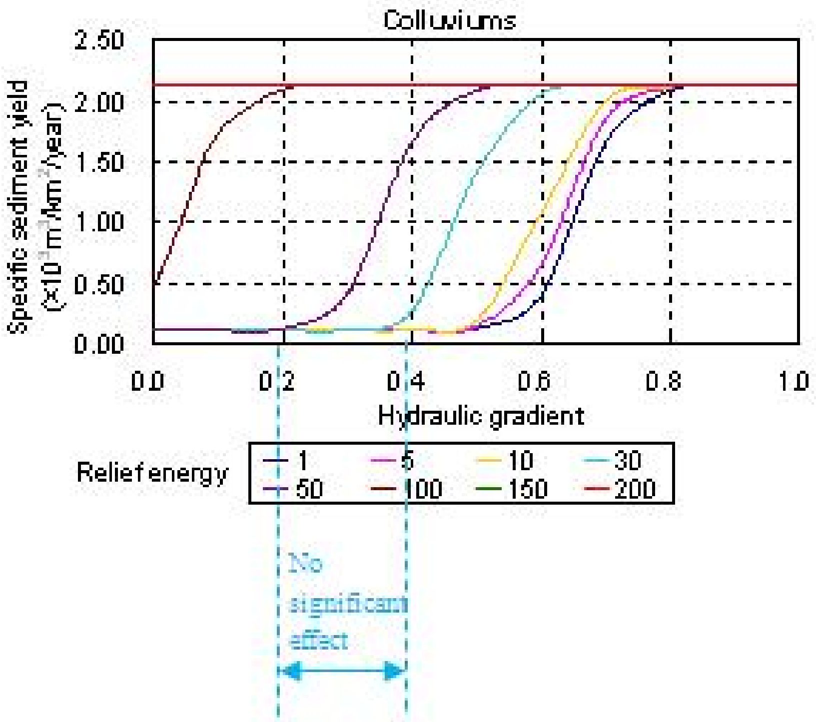

Fig. 1. Figure for comment 9