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Simulating Potential Impacts of Climate Change on Sediment Production in Western Japan

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Climate changes may cause serious water-related problems in the future, however, the influence of those changes in sediment-related issues in river basins has not been widely investigated. Climate change also influences the timing and magnitude of runoff and sediment production. There might be changes in rainfall erosivity, hydrologic processes, sediment transport capacity, and indirectly on the soil erodibility through changes in land cover and management. This study uses a continuous simulation model to assess the potential implications of climate changes on soil production and slope instability at regional scale in the western part of Japan. The specific objectives are: (1) to investigate and analyze the near future and future climate changes of western Japan; (2) to simulate the potential impacts of climate change on the spatiotemporal dynamics of runoff, soil erosion, sediment transportation and slope instability; and (3) to detect the hotspots of soil production and unstable slope probability changes. The study implemented a new developed grid-cell based distributed geohydrologic model that represents the following water and soil interaction: soil moisture accounting, runoff process generation, surface soil detachments, sediment transportation, slope instability, and dam functions to control floods and sediment discharge. Moreover, the model combines a one-dimensional kinematic wave hillslope element model and stream channel element model. Using the product of a very high-resolution atmospheric global climate model having 20-km spatial resolution (MRI-AGCM20) as the climate forcing data, the calibrated geohydrologic model was implemented with hourly output and 1-km grid resolution. The geohydrological model parameters were adjusted using observed streamflow discharge, annual dam sedimentation, and landslide inventory in order to obtain optimal model performance in major river basins, including the Yoshino and Chikugo. The products of MRI-AGCM20 used in this study consists of the present climate (1979-2003), the near future climate (2015-2039) and the future climate condition (2075-2099). Regarding climate change analysis, the seasonal patterns of precipitation are projected to be changed in the near future and future terms comparing to the present pattern. In the future climate condition, peak time and magnitude of gross precipitation in June and July decreases, while it is going to be shifted to and increase in August. In addition, monthly precipitation and surface runoff in winter season will increase. The simulation results suggest that the river basins hydrological responses to precipitation changes under the future climate is going to have direct impact on soil productions and slope instability. Hotspots of significant changes differ according to the time and location. Kochi, Tokushima, Miyazaki, Kumamoto, Hiroshima, Yamaguchi, Ehime, Shimane and Okajama Prefectures are expected to be hotspots. The following research is underway for further improvement and upgrading the simulation by utilizing MRI-RCM5km and bias-corrected MRI-GCM20, by simulating dam sedimentation and riverbed change and by conducting risk-based analysis as well as by designing feasible adaptation measures.