C304

Assessment of Sediment Hazards in a Changing Climate Considering Atmospheric Influences: A Case Study of Rokko Mountain

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Background

Estimating the future risk of sediment disasters in a changing climate have been one of essential topics recently. Some effects have been made to assess the future change of landslide alerts in Japan in a changing climate with the application of the critical line (CL for abbreviation) method (Wu et al., 2021; 2022 and related references therein). The critical line method utilizes a parametric curve of snake line, composed of hourly precipitation (*P*) and soil-water index (*SWI*), to reflect the effects of short-term rainfall and long-term soil wetness. The geometric feature of a snake line is highly affected by rainfall pattern, e.g., duration, peak intensity, and etc. The analysis of Clausius-Clapeyron scaling shows that extreme precipitation could be related to ground air temperature that can alter the capacity of water vapor in the atmosphere. Therefore, we further extend the concept of scaling analysis to soil-water index for examining the effect of ground air temperature on the maximum range of snake line. In the study, we propose two exponential scaling relations for precipitation and soil-water index in terms of ground air temperature to assess the maximum range of snake line under climate change impact with a focus on the target area of the Rokko Mountain.

Data and method

This study utilizes three kinds of datasets, including ground gauge observation at Kobe Meteorological Observatory, Radar/Raingauge-Analyzed Precipitation, and Meso-scale Model. The data period of gauge observation is 30 years (1990-2019), and one both for the other two datasets is 16 years (2006-2021) in order for the highest spatial resolution of 1-km. On the other hand, in the case study of the current research, for the analysis of the future change of snake line maximum range under extreme rainfall in July, we adapted the annual maximum daily temperature in July, averaged over the 30-yr observation from 1990 to 2020, as the reference of ground air temperature in the coordinates of 3-rd mesh in the resolution of 1-km (2020a). Then, for the temperature variation in July, we utilized the analysis result, published recently by JMA (2020b), that there are temperature increases of 1.4 and 4.3 °C under the RCP2.6 and RCP8.5 scenarios, respectively. **Fig. 1**a-c show all referenced temperature distribution.

In terms of ground air temperature T [°C], we propose two exponential scaling relations for P [mm/hr] and SWI [mm], respectively,

$$P \approx e^{\alpha T} \text{ and } SWI \approx e^{\gamma T}, \qquad (1)$$

where e denotes the exponential function; α[-] and γ [-] denote the scaling parameters for hourly precipitation and soil-water index, respectively. The analysis procedure is as below. Based on the definition of rainfall event by MLIT, we first extracted all rainfall events with its maximum *T*, *P*, and *SWI*. Then, we sorted all events in term of *T* in the ascending order. Inspired by the concept of Clausius-Clapeyron scaling analysis on precipitation, we classified the sorted events into 10 bins to ensure significant analysis with more than 100 samples in each bin. Finally, in each bin we extracted the median of *T* and 99-percentile *P* and *SWI* as representative variables for the least squared regression analysis of the two relations in Eq. (1). **Fig. 2** shows the verification using the 30-yr observation with quite high coefficient of determination (R^2). Then, regression analysis was performed for the two scaling relations on each mesh, and obtained two high averages of R^2 that are 0.92 for *P* and 0.87 for *SWI*.

Analysis results

For observation and the RCP2.6 and RCP8.5 scenarios, the maximum range of snake line on each mesh were obtained by applying the related ground air

観測平年値(1990-2020)　観測平年値＋RCP2.6偏差値(+1.4度)　観測平年値＋RCP8.5偏差値(+4.3度)

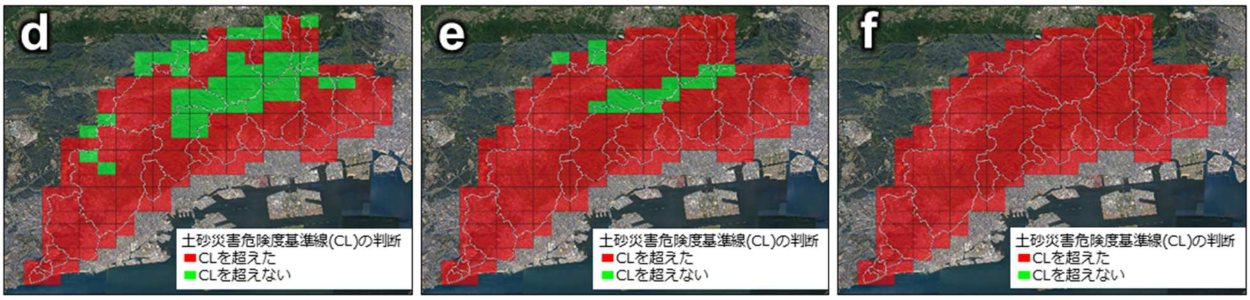

Fig. 1 Future change of maximum snake line range under extreme rainfall in July. a) Annual averaged maximum observed ground air temperature in July, b) observed temperature with variation of RCP2.6 scenario (+1.4 ºC), d) observed temperature with variation of RCP8.5 scenario (4.3 ºC). Subfigures d-f) show the results of passage of CL (red patches: passed; green ones: not passed) using the precipitation and soil-water index scaling, which are calibrated using datasets of Radar/Raingauge-Analyzed Precipitation and Meso-scale Model (MSM).

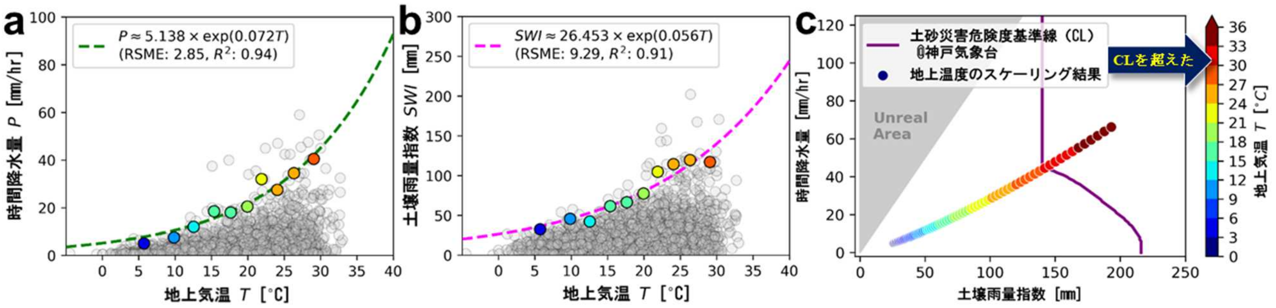

Fig. 2 Verification of scaling of (a) precipitation and (b) soil-water index using ground gauge observation at Kobe Meteorological Observatory. Data period is 30 years (from 1990 to 2019). There are totally 1, 962 precipitation event. Subfigure (c) shows the change of maximum snake line range in terms of ground air temperature using the two calibrated scaling relations in Equation (1).

temperature to the two calibrated scaling relations. The latest information of CL on each mesh was then used to judge whether the maximum range passes CL. **Fig. 1**d-f illustrate the results that there are meshes without passage of CL in the area of mountain peak and in the back side for observation. The mesh without passage of CL is further reduced for the RCP2.6 scenario. Finally, all meshes possess the maximum snake-line range passing over the corresponding CL. In the next step, more scenarios will be considered for further analysis.

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