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Effect of global warming on the hazard of sediment-related disasters in snowy regions of Japan

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The area along the Sea of Japan is known as one of the world's heavy snowfall regions, and is likely to be affected by global warming because of the low latitude of the Warm Temperate Zone. The changing snow environment is likely to affect the hazard of sediment-related disasters such as slush flows and meltwater-induced landslides. Therefore, we examined the effect of global warming on the hazard of sediment-related disasters in the snowy regions of Japan.

To clarify the mechanism of sediment-related disasters and evaluate their hazard, the water reaching the ground surface (MR) should be observed throughout the year. We conducted perennial field observation of MR using lysimeters, not only during the non-snow cover season but also during the snow cover season in a mid-land area where sediment-related disasters such as landslides occur frequently. The results of observations showed that the timing and intensity of MR vary depending on the large deviations in the seasonal snowpack environment.

In comparison with the heavy snow season and the light snow season, a high intensity of MR was observed at the beginning of snow cover and during the snow-melting period, and a large quantity of MR was recorded almost every day just before the snowpack disappeared. In the case of the light snow season, the snow accumulation was thin even in the coldest season of January or February. MR was observed intermittently throughout the snow-cover period and a large MR of 60?70 mmd^{-1} was recorded even in mid-winter.

Global warming will not bring a light snow environment but will lead to larger oscillations between heavy and light snow environments compared with at present. Therefore, in a heavy snow season, huge amounts of accumulated snow will remain till April and May when the air temperature and solar radiation increase rapidly, resulting in a higher hazard of sediment-related disasters with a longer time delay than usual. In a light snow season, MR will be observed in mid-winter in January and February due to the substitution of rainfall for snowfall and intense snowmelting, resulting in a high hazard of sediment-related disasters during this period. Therefore, the hazard of sediment-related disasters is likely to vary greatly as a result of global warming.

The regime of rain on snowpack and meltwater generated on the snow surface change during the infiltration processes of snow accumulation. If it rains with high intensity and short duration on snowpack, a regime of water from the bottom of the snowpack is transformed into low intensity and longer duration due to the buffering function of the snow. Therefore, the rainwater reaches the ground surface in a similar form of rainfall as when there is little snow accumulation.

The intensity and duration of MR affect the quantity of water infiltrating the ground. MR with moderate intensity but longer duration could infiltrate the deeper underground with larger amount of water and generate excess pore pressure resulting in deep-seated landslides. On the other hand, MR with short duration but high intensity may cause shallow landslides and debris flows. Therefore, the type and form of sediment-related disasters are expected to change since the precipitation and snow environment will fluctuate heavily as a result of global warming.

Keywords: global warming, snowy regions, sediment-related disasters, meltwater and/or rainfall