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Mudflow risk in Uzbekistan under anthropogenic climate change

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Risks out of mudflows are discussed to increase in future due to an increase in global population and enhanced anthropogenic activities in previously sparsely populated regions prone to hazardous mudflow events, specifically in mountainous areas. In addition to this, any future potential effect of anthropogenic climate change e.g. increased precipitation intensity and/or changed associated atmospheric circulation characteristics will increase the potential of hazardous mudflows by impacting on respective triggering mechanisms.

The focus of this study is to assess the impact of potential anthropogenic climate change on mudflow occurrences in Uzbekistan (especially in Gallyaaral, Zerafshan basin) in response to changed atmospheric conditions. As current state-of-the-art Atmosphere-Ocean General Circulation Models (AOGCMs) do have shortcomings in simulating extreme precipitation events, we focus on more reliable aspects of coupled global model simulations, the diagnostic of major circulation modes and related potential changes. Thus, we investigate an ensemble of 10 AOGCMs from the Coupled Model Inter-Comparison Project Phase 5 (CMIP5) under the RCP8.5 scenario with respect to changes in the atmospheric circulation. Applying the well-established Circulation Weather Types (CWT) approach for the recent (1979-2005) and future (2071-2100) climate conditions for Uzbekistan, we find changes in the large-scale flow, especially for those weather types mainly responsible for mudflow occurrences. Changed frequencies of cyclonic (C) and westerly (W) airflow directions will potentially result in more extreme mudflow occurrences during the warm season (March-August) by up to 5% to the end of the century. However, the ensemble results show uncertainties regarding the CWT south-westerly (SW) airflow associated with the most devastating mudflow events in Uzbekistan.

Additionally, we apply a statistical transfer function (logistic regression model), trained by recent observed mudflow events in relation to ECMWF Era-Interim reanalyses, to diagnose potential changes in mudflow occurrences given the changed CWT characteristics. CMIP5 AOGCM output (bias corrected) is used to diagnose the precipitation threshold triggering mudflow events by application of a statistical empirical antecedent daily rainfall model (ADRM). Results for the important weather types (C, W and SW) confirm that mudflow activity will increase in the selected region as precipitation values associated with the CWT C, W and SW flows in CMIP5 projections are expected to increase in the warm season for the target period of 2071-2100.