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Impacts of climate and land use changes on water variability, using a Budyko framework: case study in Gansu, China

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Disentangling the effects of climate and land use changes on regional hydrological conditions is critical for local water and food security. The water variability over climate transition regions at the midlatitudes is sensitive to changes in regional climate and land use. Gansu, located in northwest China, is a midlatitude climate transition region with sharp climate and vegetation gradients. In this study, the effects of climate and land□use changes on water balances are investigated over Gansu between 1981 and 2015 using a Budyko framework. Results show that there is reduced runoff generation potential over Gansu during 1981 and 2015, especially in the southern part of the region. Based on statistical scaling relationships, local runoff generation potential over Gansu are related to the El Nino-Southern Oscillation (ENSO). Intensified El Nino conditions weaken the Asian monsoons, leading to precipitation deficits over Gansu. Moreover, the regional evapotranspiration (ET) is increasing due to the warming temperature. The decreasing precipitation and increasing ET cause the decline of runoff generation potential over Gansu. Using the dynamical downscaling model outputs, the Budyko analysis indicates that increasing coverage of forests and croplands may lead to higher ET and may reduce runoff generation potential over Gansu. Moreover, the contributions of climate variability and land□use changes vary spatially. In the southwest part of Gansu, the impacts of climate variability on water variations are larger (around 80%) than that of land□use changes (around 20%), while land use changes are the dominant drivers of water variability in the southeast part of the region. The decline of runoff generation potential reveals a potential risk for local water and food security over Gansu. The water□resource assessment approach developed in this study is applicable for collaborative planning at other climate transition regions at the midlatitudes with complex climate and land types for the Belt and Road Initiative.