



Land surface changes enhanced drought over the Loess Plateau

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In order to prevent the severe soil-water erosion over the Loess Plateau (LP), the Chinese Government initiated large scale ecological restoration (ER) in the past half century. The ER had successfully reduced soil erosion however also changed the land surface and altered the regional water-energy balance and consequently the dryness/wetness conditions, which in turn affects the vegetation. Knowledge of the impacts of the ER on dryness/wetness conditions is essential for developing future effective ER measures. For this purpose, a new drought index, the standardized wetness index (SWI), was proposed. The SWI can represent the dryness/wetness brought by solely climate change (denoted as SWI_f in this case), and the dryness/wetness brought by the joint effects of climate change and land surface change (SWI_m). A total of 13 main catchments were selected to investigate the effects of ER on dryness/wetness conditions during 1961-2009 over LP. Results showed that the overall increasing parameter n (a parameter of the Budyko formulae) could be well explained by the ER measures ($R^2=1$) in these catchments. The SWI_f and SWI_m had similar fluctuating features and exhibited downward trends. However, the SWI_m had larger negative trends than the SWI_f, implying that ER actions enhanced the drought conditions over the drying LP in the past decades. Therefore, we suggest that the government should manage and maintain the existing achievements but not further expand revegetation because of unintended consequences on drought vulnerability.