Hydrological responses to agricultural land-use change and climate change in a cold semi-arid region

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Assessing the hydrological effects of agricultural land-use change and climate change is crucial because they both can significantly affect regional hydrology. Quantifying their effects can help stakeholders adapt to the changing climate but is challengeable because climate variability can always add extra complexity, and the effects of agricultural practices do not always pop up immediately and some of them are even not observable in a short time. In the Canadian Prairie region, the traditional monocultural system relying on frequent usage of summer-fallow with traditional tillage has been replaced with diversified cropping systems with no tillage in the last several decades. In this study, three adjacent 5-ha agricultural hillslopes at Swift Current Research and Development Centre on the Canadian Prairies are chosen to detect the hydrological responses to climate change and agricultural land-use shifts and to characterize the hydrological features of four agricultural systems. Based on the trend analysis, over the period of 1962-2010, the Swift Current hillslopes overall became warmer and wetter, although the nongrowing season became drier to some extent. For the hydrology responses, the land surface water resources for crop use in the growing season, such as the trapped snow, spring moisture, and nongrowing season runoff, showed declining trends. Comparing these four agricultural systems, the Wheat-Fellow with no tillage has the highest snow-trapping efficiency, runoff coefficient, and soil moisture content (spring and fall). The summer-fallow practice relying on traditional tillage does not show high efficiency in conserving soil moisture for the Wheat-Fallow rotation system, while the summer-fallow combing with no-tillage technique has relatively higher efficiency in soil moisture conservation, and the short-season green manure is also a potential alternative to traditional summer-fallow. In addition, the standing stubble is proven to be effective agricultural management in conserving land-surface water resources through tapping snow in the nongrowing season constraining soil evaporation in the growing season.