Geophysical Research Abstracts
Vol. 16, EGU2014-2508, 2014
EGU General Assembly 2014

Role of vegetation in modulating rainfall interception and soil water flux in ecosystems under transition from grassland to woodland

Chris Zou, Rodney Will, Elaine Stebler, and Lei Qiao
Oklahoma State University, Stillwater, United States (chris.zou@okstate.edu)

Vegetation exerts strong control on the hydrological budget by shielding the soil from rainfall through interception and modulating water transmission in the soil by altering soil properties and rooting zone water extraction. Therefore, a change in vegetation alters the water cycle by a combination of a passive, rainfall redistribution mechanism controlled by the physical dimensions of vegetation and active, water extracting processes resulting from physiological attributes of different plants. As a result, the role of vegetation on the water cycle is likely to change where vegetation is under transition such as in the southern Great Plains of USA due to woody plant encroachment. However, it remains largely unknown how this physiognomic transformation from herbaceous cover to woody canopy alters rainfall influx, soil water transmission and efflux from the soil profile and consequently alters historic patterns of runoff and groundwater recharge. This knowledge is critical for both water resource and ecosystem management.

We conducted a comprehensive, 5-year study involving direct quantification of throughfall and stemflow for grassland and encroached juniper woodland (Juniperus virginiana), water efflux through transpiration using an improved Granier thermal dissipation method (trees) and ET chamber (grassland), soil moisture storage and dynamics (capacitance probe) and streamflow (small catchment). We calibrated a prevailing hydrological model (SWAT) based on observed data to simulate potential change in runoff and recharge for the Cimarron River basin (study site located within this basin) under various phases of grassland to woodland transition.

Our results show that juniper encroachment reduces throughfall reaching the soil surface compared with grassland under moderate grazing. The evergreen junipers transpired water year-round including fall and winter when the warm season grasses were senescent. As a result, soil water content and soil water storage on the encroached catchment were generally lower than on the grassland catchment, especially proceeding the seasons of peak rainfall in spring and fall. Frequency and magnitude of streamflow events was observed to be substantially reduced in the encroached catchment. Model simulation suggests that conversion of all existing grassland to juniper in the Cimarron River basin will increase overall water efflux through evapotranspiration sufficient to substantially reduce water yield for streamflow. Rapid transformation of mesic grasslands to a woodland state with juniper encroachment, if not confined, has the potential to reduce soil water, streamflow and flow duration of ephemeral streams. Slowing the expansion of woody encroachment into grasslands might be considered as a land-based strategy to sustain or even augment streamflow and groundwater recharge to meet the increase in water demand under increasing climate variability and population growth in the southern Great Plains of USA