Thesis Title:

Water Transport in Different Landscapes and Water Exchange among Landscape Transition Zone in the Middle Reaches of Hehe River Basin

Abstract:

Water resources are oftentimes scarce and a restricting factor for vegetative growth in the arid inland river basins, such as occurs in the Heihe River, Northwest China. It is important to mitigate the consequences of water deficits and increase the water use efficiency, which were important for oasis ecological security maintaining. In view of the realistic conditions in the middle reaches of Heihe River basin, such as the shortage of water resources, diversified landscapes, huge irrigation amount for the farmland, long freezing/thawing period, and fragmentized landscapes distribution. The eco-hydrological processes in different landscapes and among the landscape transition zone were studied based on the field monitoring, laboratory analysis, model simulation and theory analysis. The results are outlined as follow:

(1) The soil water balance items in the farmland and forest were greater than that in the desert, resulted by the larger water input. The present irrigation schedule in the farmland and forest was unreasonable in some degree, which was identified by the large percolation. The deep soil water or the groundwater (GW) was the mainly water resource for the *sacsaoul*.

(2) The unreasonable irrigation problems in the wetland farmland, old oasis farmland and new oasis farmland were characterized by excessive total irrigation amount, uniform irrigation distribution, and overweight single irrigation amount, which resulted in the large deep percolation and hampered maize root water uptake. For the optimized irrigation schedules, relatively few irrigation times and large single irrigation amount could be applied in the old oasis maize field (40~70 mm per time for 6 times). In contrast, more frequently and less single irrigation amount could be applied in the new oasis maize field for optimized irrigation strategy (30~50 mm per time for 12 times). Meanwhile, more GW was consumed in the wetland farmland by the crop transpiration and soil evaporation.

(3) The greatest freezing and thawing processes were observed in the farmland, followed by the forest, and then the desert, characterized with the deeper frost depths and longer continuous frost days in the farmland and forest. The combination of Neutron Moisture Meter and Time Domain Reflectometry was successful to measure the soil ice content. Profiled water redistribution was only obviously observed in the moist forest. The fluctuations of GW level were sensitive to the freezing and thawing processes, which decreased in the freezing period and increased in the thawing period.

(4) The hydrological links among the three landscapes were exhibited in three patterns. First, the soil water of the upper soil layer near the interface of two land use units moved from the irrigated land use unit to the non-irrigated one under soil water potential gradients through physical diffusion (the lateral water flow rate was less than 1 cm d^{-1}). Second, the water flowed from the irrigated land use unit to the non-irrigated one under GW level gradients through GW flow (the lateral groundwater flow rate was less than 10 cm d^{-1}). Third, a portion of the soil water in the farmland was utilized by the extended root system of the trees. The water exchange between the farmland and the forest resulting from one irrigation event was 5 mm to 30 mm, which caused increased GW Levels for 1 week, which was longer than that

between the farmland/forest and desert.

(5) There was a vegetation growth gradient (e.g., root biomass, above-ground biomass, tree height) along the transition zone. At the forest–farmland boundary, the impacts of the extended tree roots reduced maize growth and extended 10 m to 15 m into the farmland. By contrast, no obvious impacts were observed at the forest-desert boundary. Irrigating the farmland and the forest separately and reducing the width of the forest by 15 m to 20 m would be more beneficial for irrigation water efficiency.

(6) The water cycle would be affected by the soil distribution, regional GW movement and local water pumping, except for the irrigation and vegetation factors. The water exchange between the farmland and the forest was enhanced by the aquifuge located in the farmland and forest, as the deep percolation was reduced obviously. The regional GW decrement and local water pumping resulted in the accelerated water move from farmland to the forest or the desert, and finally leaded to the decreased irrigation water use efficiency.

Key works:

Water balance; Landscape transition zone; Water exchange; Ecological effect; HYDRUS