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Track 2: Soils

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CONTROLLED DRAINAGE IN WESTERN KENTUCKY: MITIGATING WATER STRESS AND REDUCING NUTRIENT LOSS TO SURFACE WATERS IN GRAIN CROP PRODUCTION

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Water is often a limiting factor for grain crop yield in Kentucky. This study explored controlled drainage (CD) of field tiles as an option for increasing water availability to these crops. In this system, CD structures were installed into fields where subsurface tile drainage already existed. Gates were taken in and out of these structures for management of the water table in the field based on timing of rainfall and time of year. Water conservation through CD was hypothesized to alleviate water stress, increase nutrient availability, decrease winter nutrient loss, and increase yields of Kentucky grain crops. No scientific research had been done to determine the effect of CD on crop yield, soil nutrient levels, nutrient loss through drainage water, or water availability in Kentucky. To determine these effects we chose two fields in Muhlenberg county Kentucky for their similarity in soil type (Belknap silt loam), size, and slope. The cooperator employs the same management practices in each field for a rotation of corn, wheat, double crop soybeans. The CD structures installed at the main tile outlets were closed for one field and left open for the second field. Yield was determined for each field by hand harvesting from six locations across the field and by whole-field yield estimates taken by the producer. Soil samples were taken immediately following hand harvest of double crop soybeans in 2015. To determine the amount of nutrient loss from the agricultural field, grab samples were taken in May of 2014 and August of 2015. We had intended to collect water quality samples once a month; unfortunately there was very little rainfall at the site from July to October 2015. Additionally our cooperator asked that we no longer collect water quality data from this site. The two samples collected were analyzed for nitrate as N, nitrite as N, orthophosphates as P, phosphate calc analyte, total phosphorous, total Kjeldahl nitrogen, and total nitrogen calc analyte by a nationally accredited analytics laboratory (McCoy and McCoy Laboratories; Madisonville, KY). Although, we will be unable to complete the water quality portion of this project, it still has potential to greatly reduce non-point source pollution by encouraging grain crop producers to implement controlled drainage technology for increases in yield and profitability.
Hydrologic models often incorporate soil properties, including field capacity, total porosity, available water holding capacity, soil thickness, and saturated hydraulic conductivity. Soil carbon content, which is expected to increase under soil-health management practices that include conservation tillage and cover crops, has been linked to hydrologic properties that include soil-water retention and hydraulic conductivity. Obtaining soil hydrologic property data can be costly and cumbersome. This study utilizes equation-derived estimates for hydrologic properties from Rawls et al. (2006) and validates them using field and laboratory data from the Shawnee Hills Loess Catena Studies Project. The Shawnee Hills Loess Catena Studies Project consists of six catenas in MLRA 120. The comparisons between the equation-derived estimates and field obtained values showed no significant differences for field capacity (FC), permanent wilting point (PWP) and saturated hydraulic conductivity (Ksat) in “A” horizons according to the Wilcoxon-signed rank test. In contrast, soil properties for the “B” horizons of the same soils showed statistically significant differences for each property under at least one vegetation type. This suggests that the equation would need to be modified to have a better correlation to simulate plant available water throughout the soil profile. These results will later be used to inform a hydrological model with estimated soil properties that reflect changes in soil carbon as a function of land management.
The evaluation of infiltration rates is vital for calculation of surface runoff in order to reduce the risk of pollutants in the environment and to proficiently apply water and fertilizers for a crop’s benefit. The objectives of this study were (1) to assess the impacts of six agroecosystems on infiltration rates; (2) to observe the temporal variability of soil infiltration rates under various seasons (fall-spring-summer-fall); and (3) to quantify the relationships between soil infiltration rates with other properties including soil organic carbon (SOC), macroaggregates, and bulk density. The study was held in Calloway County of western Kentucky. The ecosystems consisted of no-till corn, conventional tillage soybeans, conventional tillage tobacco, organically grown vegetables, woodland, and prairie. All of the soils used in this study have a silt loam texture. The infiltration rates were measured using a single ring infiltrometer. Soil organic carbon (SOC) was measured using the loss on ignition (LOI) method. Macroaggregates and bulk density were determined using wet sieving and ring methods, respectively. The data were statistically analyzed using ANOVA followed by the least significant difference (LSD) test at α 5%. The results show that organic farming and the wooded system have the highest infiltration rates (35.2 cm/hr and 37.7 cm/hr) and the lowest bulk densities (1.0 g/cm³ and 1.1 g/cm³), respectively. The relationship between infiltration rate and organic carbon, bulk density, macroporosity, and total porosity was r²=.99, r²=.60, r²=.69, and r²=.66. The no-till corn field had a higher bulk density than the conventionally tilled systems (1.7 g/cm³) and lower total porosity of 37%, but had a higher infiltration rate than the conventionally tilled systems at approximately 12.9 cm/hr. The organic system had a 60% lower bulk density than the no-till corn, which were the highest and lowest bulk densities, respectively. The most dramatic differences amongst infiltration rate occurred in the wooded system which increased from 36.3 cm/hr in the fall of 2013 to 39.3 cm/hr in the summer of 2014. Amongst the averages, however, which range from 4.3 cm/hr to 37.7 cm/hr, the seasonal changes were not significant.
INVESTIGATION OF THE CLIMATE MODELING FACTORS IMPACTING FORECASTED STREAMFLOW FOR CENTRAL KENTUCKY

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The present investigation quantifies the relative importance of climate modeling factors and chosen response variables upon controlling the variance of streamflow forecasted with global circulation model projections. We designed an experiment that varied climate modeling factors (including global circulation model type, project phase, emission scenario, downscaling method, and bias correction) as well as the streamflow response variable (including the forecasted streamflow and the percent difference in forecast and hindcast streamflow predictions). Publically available global circulation model results and the Soil Water Assessment Tool (SWAT) were used to predict streamflow for the South Elkhorn Creek watershed, Kentucky, USA. 113 SWAT model runs were used and analyzed on a monthly basis using analysis of variance. Analysis of variance results indicate that the prediction of the change in streamflow, when considering hindcast simulations, is a function of global circulation model type, climate model project phase, and downscaling approach. The prediction of forecasted streamflow, when not subtracting the hindcast simulation, is a function of global circulation model type, project phase, downscaling method, emission scenario, and bias correction method. Our results suggest that some uncertainty associated with the parameterization in the individual global circulation models is also reduced when
subtracting the hindcast simulations. Overall, the prediction of the change in streamflow is more certain because we have accounted for the uncertainty introduced during coupling of the global circulation models to the hydrologic model by subtracting the hindcast streamflow. Moreover, when predicting the mean and variance of streamflow, use of excessive numbers of realizations appears unneeded for the study system, so long as the ensemble design is well balanced. Results suggest an increase in the average annual temperature, precipitation and streamflow by 3.0°C, 9.65% and 11.2%, respectively, for the future period 2046 to 2065 as compared to the hindcast period 1981 to 2000.