2019 Annual Water Sustainability Fund Report for Project 5192

Quantifying the Impact of Eastern Red Cedar Encroachment on Recharge in the Nebraska Sandhills

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We have accomplished a lot in the last year. One PhD student arrived in August. He specializes in GIS and remote sensing. He has three objectives that will improve the modeling of the Nebraska Sandhills and will help us understand the impact of Red Cedar encroachment in the Nebraska Sandhills. First he is evaluating how climate impacts the thousands of lakes in the Sandhills. Specifically he is evaluating how the Palmer Drought Severity Index (PDSI) correlates to the area of the lakes over time. Figure 1 illustrates the lakes during a drought year (2012) and wet year (2015). Satellite images from Landsat system (Landsat-OLI, TM and MSS) were processed in google earth engine for more than 30 years. We processed 140 Landsat scenes from 1984 to 2018 and calculated the lake area in the study area. Modified normalized difference index (MNDWI) was used to extract the lakes, while lake area smaller than 0.4 hectare were eliminated to compensate any ambiguities on object identification from Landsat system. We used PDSI from University of Idaho in google earth engine. The PDSI collection ranges from 1979-present with high spatial resolution of (~4km) with dekadal (10 day) estimates. The PDSI values were lagged for 36 dekads for every lake area extracted from images to evaluate the effect of lagged time on lake area. Similarly, cumulative PDSI values for lagged time were calculated. A correlation analysis shows that the correlation increases to about 50% (15^{th} dekad) when cumulative lagged PDSI values were used. Multiple linear regression along with neural network and fuzzy logic approaches are being explored for reliable estimate of the lake area. The goal will be to predict the future area of the lakes based on current and past climate. This will be beneficial in understanding the hydrology of the system.

The second objective will be to quantify the current status of the Eastern Red Cedar within our study area. We have purchased Rapid Eye images from 2018 and will purchase historical images this year. These images will be analyzed later this year. This information will be included in our model to determine the impact of the Red Cedar on water resources within the Sandhills.

The third objective will be to use the lakes as monitoring wells as the lakes are basically where the groundwater is above the surface. With a limited number of monitoring wells in our study area, the lakes can help us create a more detailed water table map. This will improve our understanding and modeling of the hydrology in the Sandhills.

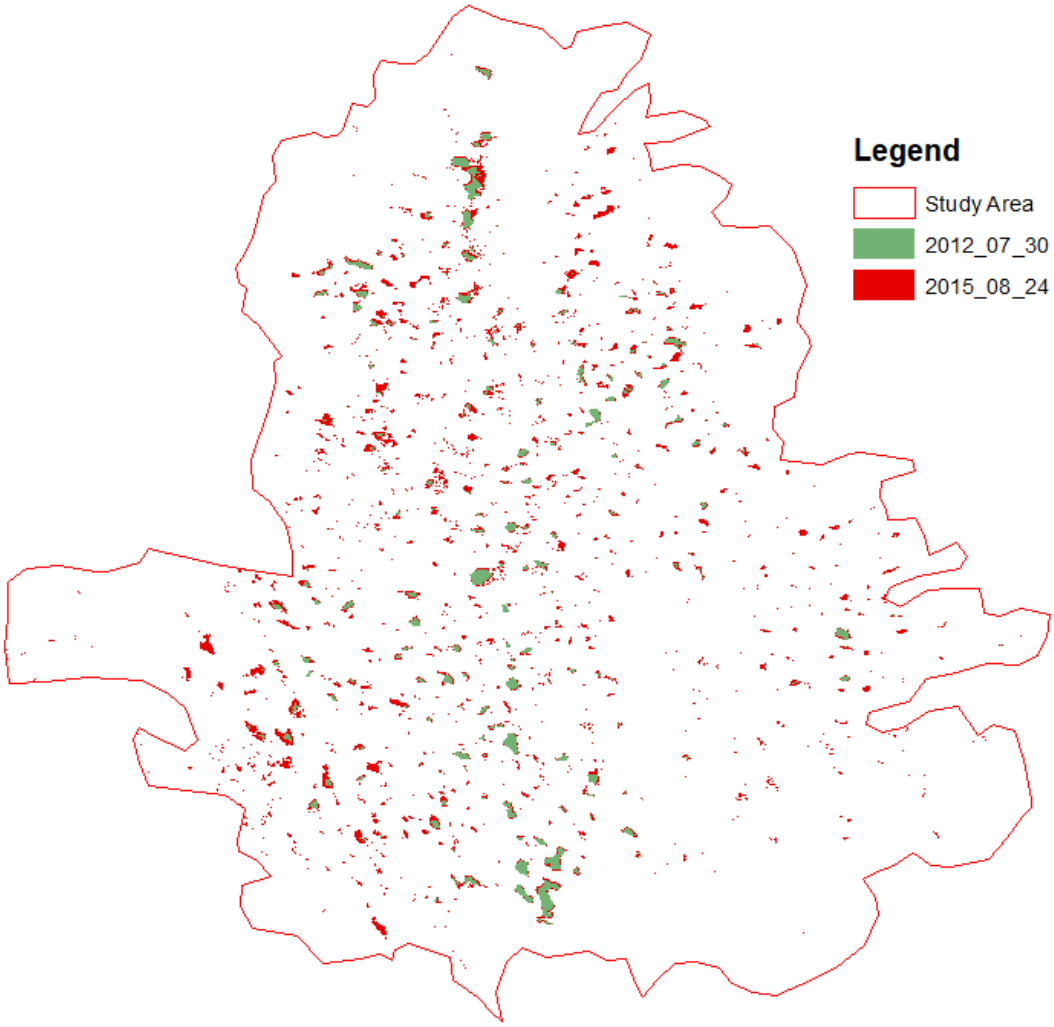

Figure 1. The lake areas in 2012 (drought year) compared to 2015 (wet year). Red indicates where there was water in 2015, but not in 2012. Green indicates where there was water in 2012.

The second student that will be working on this project started in January and is also pursuing his PhD. His expertise are in surface and groundwater modeling. Though he just started a few months ago, he has made great progress in setting up the surface water model for the Upper Middle Loup using SWAT. The 30 meters DEM was used to perform the delineation, flow direction and accumulation, outlet/inlet definition and calculate the watersheds and sub-basins of the Upper Middle Loop Area (Figure 2). Additionally, the Hydrological Responses Units (HURs) for the targeted area have been created using the land use, soil and slope of the study area. The land use is made up of water, wetlands,

low-density developed, forest, pasture and corn. The slope categories were divided into five categories (0-5%, 5-10%, 10-15%, 15-20% and >20%).

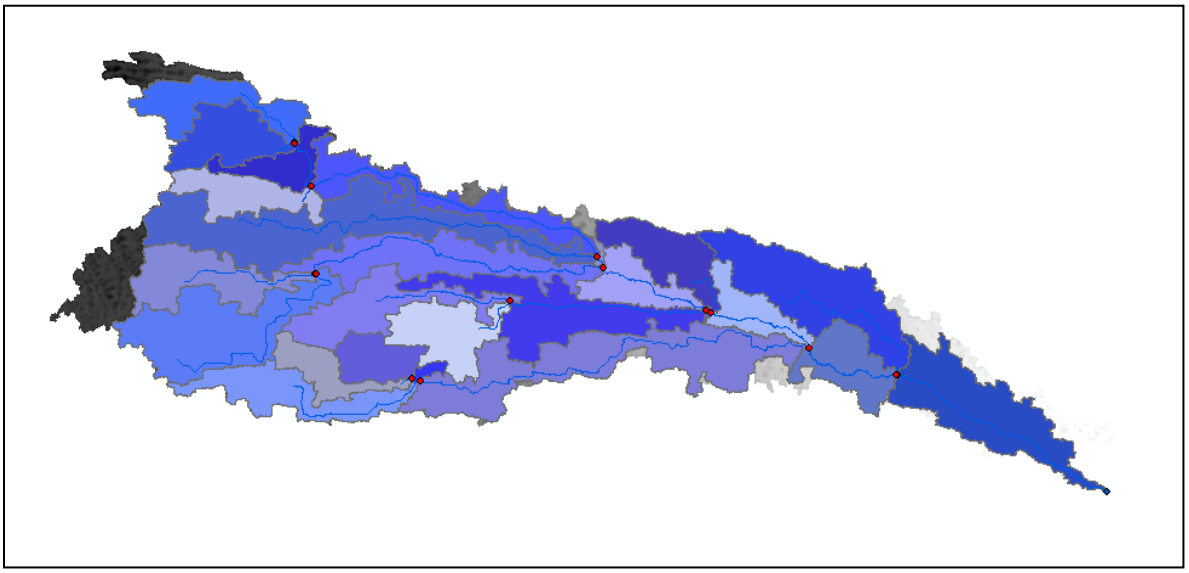

Figure 2: Sub basins Shapefile of our study area, the Upper Middle Loop.

The next step will be to calibrate the surface water model and then create a groundwater model using MODFLOW. The models will then be coupled and multiple Red Cedar encroachment scenarios will be simulated.

I'm excited with our current progress and the students conducting the work. We are on schedule to not only complete what we stated to do in the application, but conduct additional work that will help us better understand the hydrology of the Sandhills and the impact of Red Cedar on our water resources. Below is a general outline for the remainder of the project.

April 2019 to March 2020	• Identify current and historical Eastern Red Cedar status in the study site • Develop framework for Red Cedar prediction model • Construct SWAT and MODFLOW models
April 2020 to March 2021	• Predict Red Cedar encroachment based on current and alternative management for the next 10-100 years • Calibrate and conduct simulations with various levels of Red Cedar encroachment • Present findings at national conference

April 2021 to December 2021	• Quantify impact of Red Cedar encroachment on water resources in the Loup and Platte River watersheds • Provide report to DNR • Present findings at national conference