**LTAR name: Platte River High Plains Aquifer Nebraska (PRHP)**

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**Regional scientific knowledge gaps and resource concerns related to specified water and/or nutrient budget:**

Increased runoff from erratic and intensive rainfall events have resulted in increased soil erosion, runoff and surface water contamination. Phosphorus, nitrogen, sediments and agrochemicals have had a negative impact on surface water bodies. For instance, the prevalence of blue green algal blooms has increased with as well as cyanotoxins (Al-Sammak *et al*., 2014). LTAR sites rely on ground water from the Ogallala High Plains Aquifer for irrigation of its croplands. Fairly recently, increased nitrate applications of inorganic fertilizers and animal manure, have contaminated ground water by reacting with inert uranium, modifying uranium’s solubility and mobility (Nolan and Weber, 2015).Water stagnation in lower lying areas results in anaerobic conditions that promote denitrification. Zero-till practices have seen a rise in phosphorus stratification with high P concentrations in the top soil surface resulting in high P concentrations in runoff water (Garcia *et al*., 2007; Quincke *et al*., 2007).

Al-Sammak, M.A., Hoagland, K.D., Cassada, D. and Snow, D.D., 2014. Co-occurrence of the cyanotoxins BMAA, DABA and anatoxin-a in Nebraska reservoirs, fish, and aquatic plants. Toxins, 6(2), pp.488-508.

Garcia, J.P., Wortmann, C.S., Mamo, M., Drijber, R. and Tarkalson, D., 2007. One-time tillage of no-till. Agronomy Journal, 99(4), pp.1093-1103.

Quincke, J.A., Wortmann, C.S., Mamo, M., Franti, T., Drijber, R.A. and Garcia, J.P., 2007. One-time tillage of no-till systems. Agronomy Journal, 99(4), pp.1104-1110.

**Site description:**

In order to calculate the Business As Usual (BAU) budget; available data from the Site 1 (continuous corn under irrigation) together with modelled data from a hypothetical field (64.75 ha) characteristic of eastern Nebraska’s continuous corn growing under a reduced tillage management system were both utilized. The Soil and Water Assessment Tool (SWAT version2009) (Gassman et al., 2007) was used for estimating some components of the water budget, specifically water storage. Datasets utilized ranged from 2002 to 2012. Prior to 2005, the field was under zero-till management. However, as the yields declined due to increased plant residues (e.g. corn stalks) it was necessary to introduce mulch tillage beginning in the year 2005 (Verma et al., 2012). Fertilizers were surface applied (broadcast application) and incorporated through tillage prior to planting. Pre-emergence herbicides were also incorporated through tillage. During rapid vegetative development, foliar application of nitrogen nutrients were conducted. Irrigation was scheduled based on plant available soil moisture. The field is generally flat (0.04 slope). The characteristic of the soil that makes the majority of the hypothetical field is a fairly permeable upland Yutan silty clay loam soil (Mollic Hapludalfs).

Verma, S.B., Cassman, K.G., Arkebauer, T.J., Hubbard, K.G., Knops, J.M. and Suyker, A.E., 2012. Carbon Sequestration in Dryland and Irrigated Agroecosystems: Quantification at Different Scales for Improved Prediction (No. DOE/ER/63639). University of Nebraska-Lincoln Lincoln, NE 68583.

Van Liew, M.W., Feng, S. and Pathak, T.B., 2013. Assessing climate change impacts on water balance, runoff, and water quality at the field scale for four locations in the heartland. Transactions of the Asabe, 56(3), pp.883-900.

Gassman, P.W., Reyes, M.R., Green, C.H. and Arnold, J.G., 2007. The soil and water assessment tool: historical development, applications, and future research directions. Transactions of the ASABE, 50(4), pp.1211-1250.

**Water budget summary:**

Actual records of the water inputs to this continuous corn cropping management system include approximately 250 mm of irrigation (30%) and approximately 576 mm of rainfall (70%) each year. The outputs from this field include both runoff and deep percolation. Based on studies by Szilagyi et al., (2005), runoff makes approximately 11 % of precipitation (63.4 mm). The recharge amounts to the underlying aquifer (percolate) to approximately the same (10% of precipitation) for Saunders County (57.6 mm).

Estimates of the changes in soil water storage followed the example of CMRB LTAR in order to minimize the changes in soil water storage in a hydrological year. The differences ranged from 1.38 to 96.96 mm which represented less than 1% to about 16.8% of average precipitation.

**Details of the water budget:**

All the components of the water budget are average annual (hydrologic year) values, averaged over 13 years (Oct 2001 - Sept 2013).

* **Water Inputs:**

Daily precipitation records were obtained from the High Plains Regional Climate Center’s secured database http://hprcc.unl.edu/onlinedataservices.php#data. The accuracy of these measurements are excellent.

Irrigation amounts were estimated from records on site history operations of the continuous corn site (2002 to 2012 omitting 2010 when hail damage occurred (e.g. Suyker and Verma, 2008; 2009).

* **Water outputs**:

Evapotranspiration, estimates were simulated using the Soil Water Assessment Tool (SWAT). The model was set to estimate evapotranspiration using the Hargreaves method. Based on extension research data, corn requires approximately 635 mm of water during the growing season in Eastern Nebraska (Klocke et al, 1990). Therefore, the accuracy of actual ET estimates is relatively good since most evapotranspiration occurs over the growing season (late April to mid-October).

Soil surface and lateral runoff were estimated as a total of 11% of the precipitation following Szilagyi et al., (2005). Deep percolation or recharge was estimated as being about 10% of the precipitation (Szilagyi et al., 2005). Using outputs from SWAT model, the average difference in soil water measured at the start and end of the hydrological years was 31.2 mm.

References

Klocke, L.N., Hubbard, K.G., Kranz, W.L. and Watts, D.G., 1990. Evapotranspiration (ET) or Crop Water Use Neb Guide G90-992-A. Cooperative Extension, Institute of Agriculture and Natural Resources, University of Nebraska, Lincoln.

Suyker, A.E. and Verma, S.B., 2008. Interannual water vapor and energy exchange in an irrigated maize-based agroecosystem. Agricultural and Forest Meteorology, 148(3), pp.417-427.

Suyker, A.E. and Verma, S.B., 2009. Evapotranspiration of irrigated and rainfed maize–soybean cropping systems. Agricultural and Forest Meteorology, 149(3), pp.443-452.

Szilagyi, J., Harvey, F.E. and Ayers, J.F., 2005. Regional estimation of total recharge to ground water in Nebraska. Ground Water, 43(1), pp.63-69.

Precipitation

ET

Surface Runoff

Sub-surface flow

Change in soil water storage

Percolation

|  |  |  |
| --- | --- | --- |
| **Parameter** | **Value**  **(mm)** | Relative value (%) |
| **Inputs** |  |  |
| Precipitation | 572 | 70% |
| Irrigation | 250 | 30% |
| ***Total Inputs*** | 822 | 100% |
|  |  |  |
| **Outputs** |  |  |
| ET | 662 | 85% |
| Surface and subsurface flow | 63 | 8% |
| Percolation | 57 | 7% |
| ***Total Outputs*** | 782 | 100% |
|  |  |  |
| **Storage/Cycling** |  |  |
| Change in soil water content under BAU practices (~steady-state) | 31 | ~0.2-4% |
|  |  |  |
| **Partial Budget** |  |  |
| ***Inputs - Outputs*** | 40 |  |

**Describe an aspirational water budget:**

With regards to water, aspirational management could benefit from:

* Edge of the field buffer strips that increase soil water infiltration to reduce runoff, sediments and nutrients into channels and creeks in the watershed.
* Cover cropping to increase water infiltration and prevent nutrient losses and groundwater contamination.
* Planting drought resistant crops that can withstand water stresses and that do not require as many irrigation events (e.g. the application of deficit irrigation).
* Variable rate irrigation

Aspirational goals for water budget

* Decrease irrigation amounts and events by smart irrigation-scheduling (or deficit irrigation).
* Storm water and/or rainwater harvesting. Reduce runoff by 20%
* Increase soil water storage by creating mounds/ridge furrow systems that reduce water movement along the contour reducing runoff by 20%
* Pragmatic selection of corn hybrids, planting densities etc. that increase water use efficiency thereby increasing crop yields by 20%.