WATER DYNAMICS OF LAND USE CHANGE LINKS TO CROPS, LAND AND AGRONOMY

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Introduction

Changes in land use-land cover alter many environmental parameters, such as soil properties, water fluxes and water availability. In agro-ecosystems (agricultural and bioenergy), the change in water exchange between land and atmosphere (evapotranspiration, ET) is key to net flow and availability of water on surface and below ground. In this study we examined changes in evapotranspiration due to land use change from an agricultural land vs. grassland to bioenergy production. To describe the effect of land use change on the ET fluxes we also examined the role of crop choices, soil and land quality, and agronomic management over a 2 year transition period to three bioenergy cropping systems: Corn, Switchgrass and native Prairie.

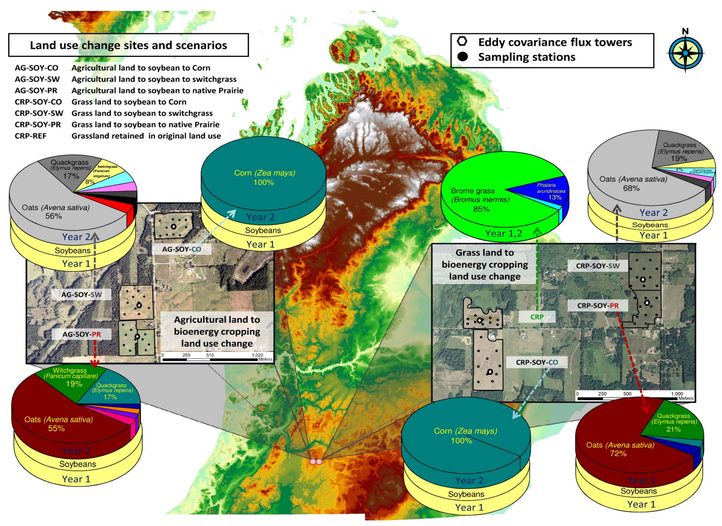

Figure 1: Land use change study sites, land cover scenarios and composition.

Methods

Our study sites were located in southwest Michigan, and constituted seven experimental units of 9–21 ha size (Fig. 1). Land use change (LUC) experiments for biofuel production were started on these units by converting two types of land uses (CRP grasslands and active agricultural lands) into bioenergy cropping. Before conversion, three of the sites (AG-XXX-XX) were in a corn–soybean rotation for >10 years, while the other three (CRP-XXX-XX) were enrolled in the CRP of the United States Department of Agriculture (USDA) for the past 20 years. A reference site (CRP-REF) was also under CRP for 20 years and remained dominated by Smooth Brome (*Bromus inermis* Leyss) grass.

The turbulent exchange of CO_2 and H_2O between the vegetation canopy and atmosphere was measured using eddy-covariance flux methods. A 3-m high tower was located close to the center of each site (Fig. 6). The eddy-covariance system on each tower consisted of a LI-7500 open-path infrared gas analyzer (IRGA) (Li-Cor Biosciences, Lincoln, NE, USA), a CSAT3 three-dimensional sonic anemometer (Campbell Scientific Inc., Logan, UT, USA), and a CR5000 data logger (Campbell Scientific Inc.).

Objectives

1. To compare effects of land use change from an agricultural land vs. a grassland to bioenergy production on water exchange between land and atmosphere.
2. Analyze the effects of crop choices, land management and agronomy on the ET losses and their implications for landscape water availability.

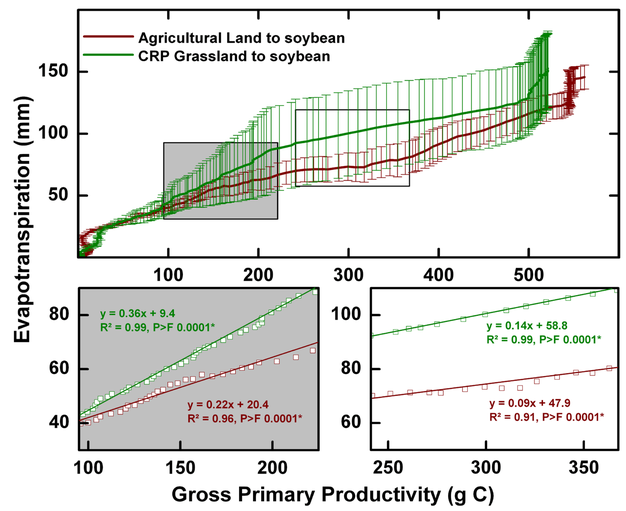

Figure 2 (above): Differences in water losses during year 1 from two types of land use changes.

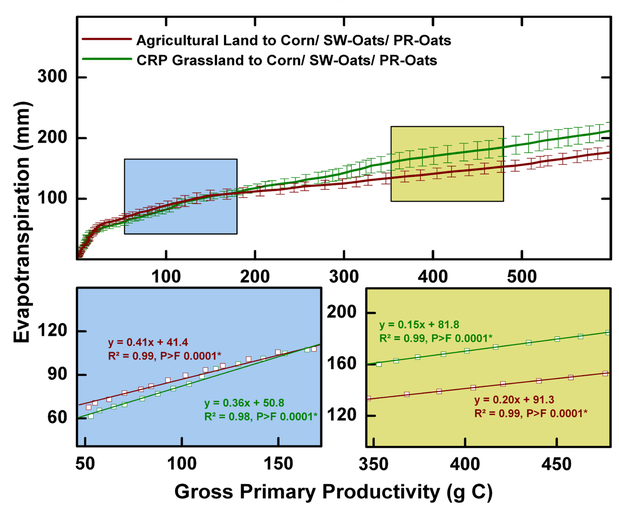

Figure 3 (above): Differences in water losses during year 2 from two types of land use changes.

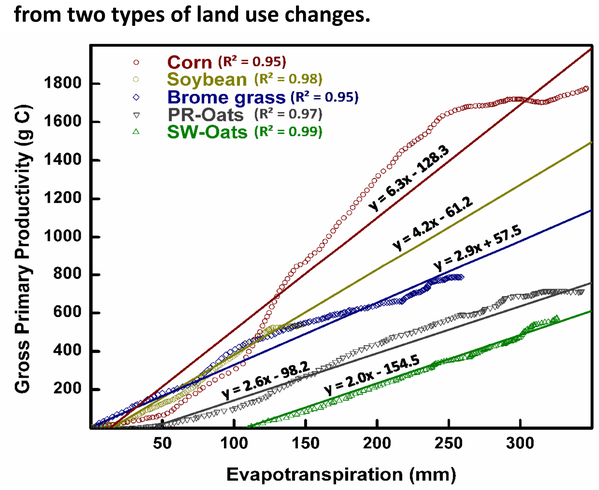

Figure 5 (Left): Crop season Photosynthetic water productivity (PWP)for the crops on the converted sites.

Results

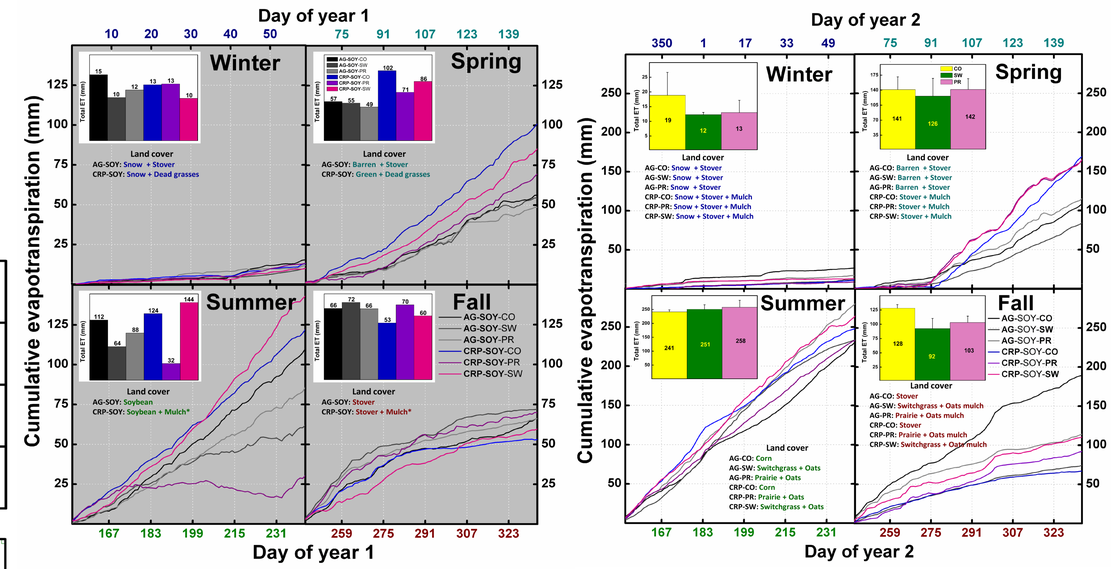

Figure 4 (above): Seasonal changes in cumulative ET as function of crops, land quality and agronomy.

Figure 6(above): Eddy covariance flux towers on some of the studied sites.

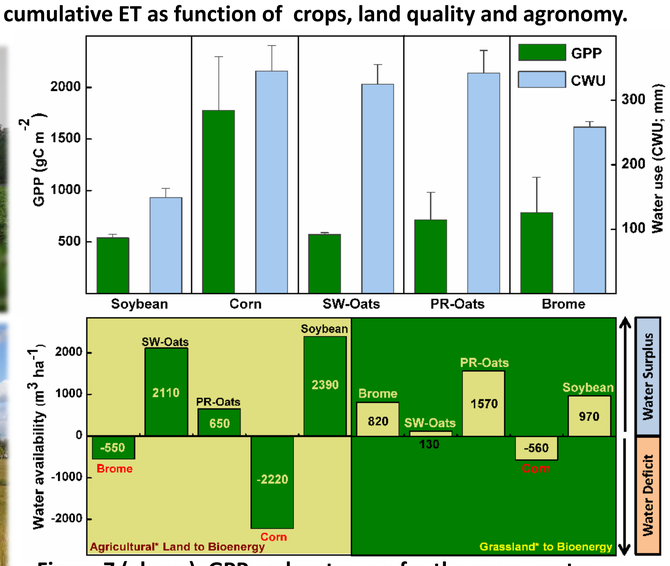

Figure 7 (above): GPP and water use for the crops; water availability consequences (water surplus and water deficit landscapes) of the land cover change to some bioenergy crops tested on these sites.

During the first year of conversion, land use history played an important role via soil and land quality effects on crop growth (Fig.2), leading to substantial differences in ET losses (Fig. 4). By second year these effects diminished during the crop establishment period but still evident during growth period (Fig. 3). Total water use during growing season was also affected by crop choices (Fig. 5). Based on total water losses during the study period, only conversion to corn (continuous) changed a landscape to water deficit for grassland to bioenergy scenarios; while conversion to corn (continuous) as well as Brome grass (CRP) changed a landscape to water deficit for cropland to bioenergy scenario (Fig. 7).

Conclusions

Our results indicated that crops as well as agronomy played an important role in determining annual water balance and availability of water in a landscape. Water availability in a landscape will be determined by the crops and agronomic practices followed. High water use crop will lead to water deficit landscapes and low water use crop may provide water surplus in a landscape. This could have large implications for water allocation and water availability to communities in the supported ecosystems.