DISAPPEARING LAKES: GROUNDWATER LEVELS IN CENTRAL WISCONSIN

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Introduction

Significant decline in depth to the water table in the Wisconsin Central Sand Plain (WCSP), especially Portage and Waushara counties, has caused concern over the increase in land area devoted to irrigated agricultural crop production. The decrease in groundwater elevation, lake levels, and stream flows, has significant impacts on aquatic ecosystems, recreational uses of streams and lakes, and property values of riparian lands (Fig. 1). Since 2002, water table levels in parts of the WCSP have dropped over 30 cm per year. Thus, we conducted a study to investigate the interactions between vegetation (irrigated agricultural crops, prairie, and forest) and depth to groundwater in the WCSP. The purpose of this study is to understand the degree to which these groundwater fluctuations are driven by climate changes or increasing irrigated agriculture. After collecting over 18 months of continuous water table elevation data under several vegetation types, we can see effects of vegetation cover and irrigation practices on fluctuation patterns in the water table. The data show clear differences in recharge and discharge behavior of the water table under irrigated crops and natural vegetations. The groundwater monitoring site location within the groundwatershed also influenced recharge characteristics. The impact of seasonal changes on the water table is also apparent. We will continue to expand our current database of groundwater elevations to further understand vegetation and irrigation impacts on groundwater levels.

A variety of vegetation types are present in WCSP including dryland agricultural crops, irrigated agricultural crops, and several natural vegetation covers. For this study, shallow groundwater monitoring wells were installed and implemented with groundwater level monitoring equipment, a rain gauge, and a soil moisture sensor. The eight sites are located in several different vegetation types including a pine plantation, irrigated sweet corn, irrigated soybeans (two sites), irrigated oats, irrigated potato, a mixed prairie including mature trees and grasses, and a native grassland. At each of these sites, groundwater table elevation and precipitation data are recorded every 15 minutes. Our data show that groundwater recharge patterns varied by vegetation type, seasonally, and according to location within the groundwatershed.

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Fig. 1. Long Lake near Plainfield, WI in May 2008.

Groundwater Fluctuations and Vegetation Cover

After snowmelt events in winter 2008-2009, prairie vegetation resulted in a 7.5 cm greater rise in the water table than agricultural fields (Fig. 2). The lack of plant residue cover on agricultural fields leads to a continuous layer of frost in the soil profile that extended to a depth of about one meter. Cemented frost in the soil profile reduced snowmelt water from infiltrating and recharging the groundwater. Increased residue on the surface of agricultural fields may enhance recharge to the water table in this region.

In a pine forest site, precipitation events from July 2008 to February 2009 yielded little to no recharge to the water table (Fig. 3). In areas where groundwater is close to the soil surface, vegetative characteristics become important to recharge trends of the water table. Interception by tree canopies and decomposing vegetative layers on the soil surface can hinder infiltration of precipitation into the soil and eventually water drainage to the water table. Precipitation intercepted by canopies and duff layers then evaporates from those surfaces instead of infiltrating into the soil profile.

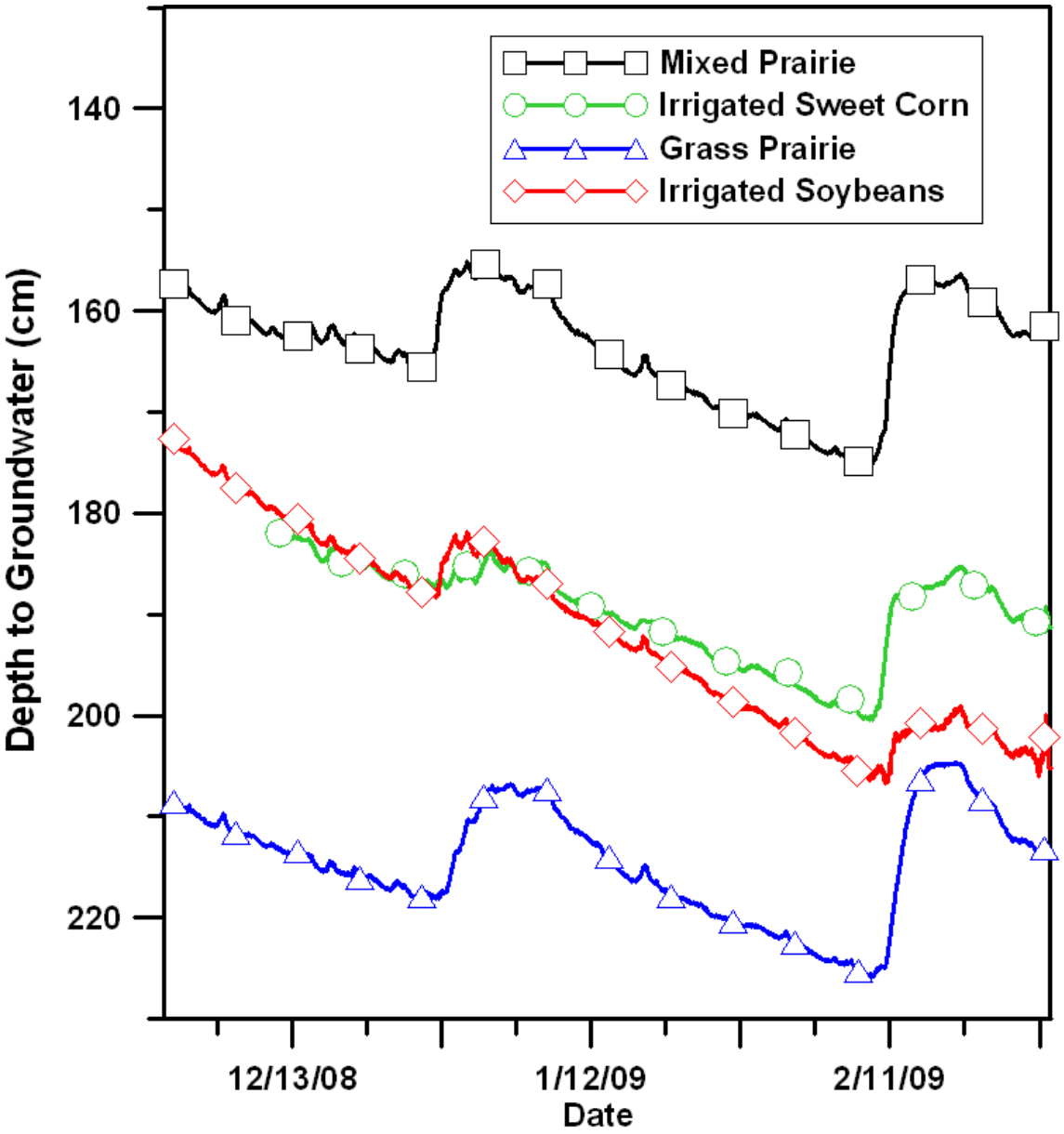

Fig. 2. Depth to groundwater under natural vegetation and agricultural land for December 1, 2008-March 1, 2009.

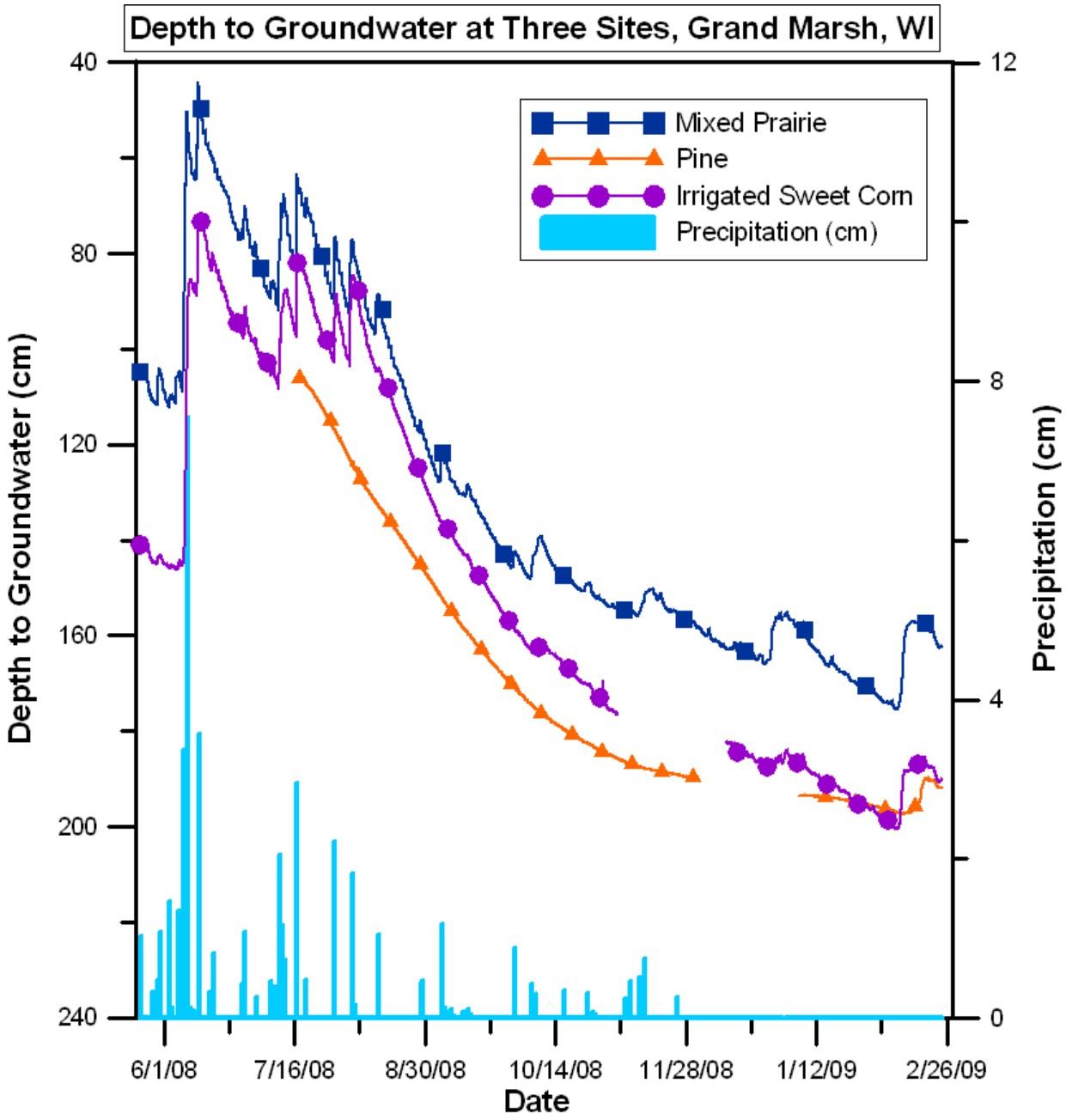

Fig. 3. Depth to groundwater at three sites near Westfield, WI.

Site Location and Groundwater Recharge Patterns

Monitoring sites in the discharge area of the groundwatershed responded quickly to precipitation events and the amount of rise in the water table increased linearly with precipitation. While agricultural crops used groundwater through irrigation, natural vegetation relied on the water table for daily transpiration needs in shallow groundwater areas (Fig. 4).

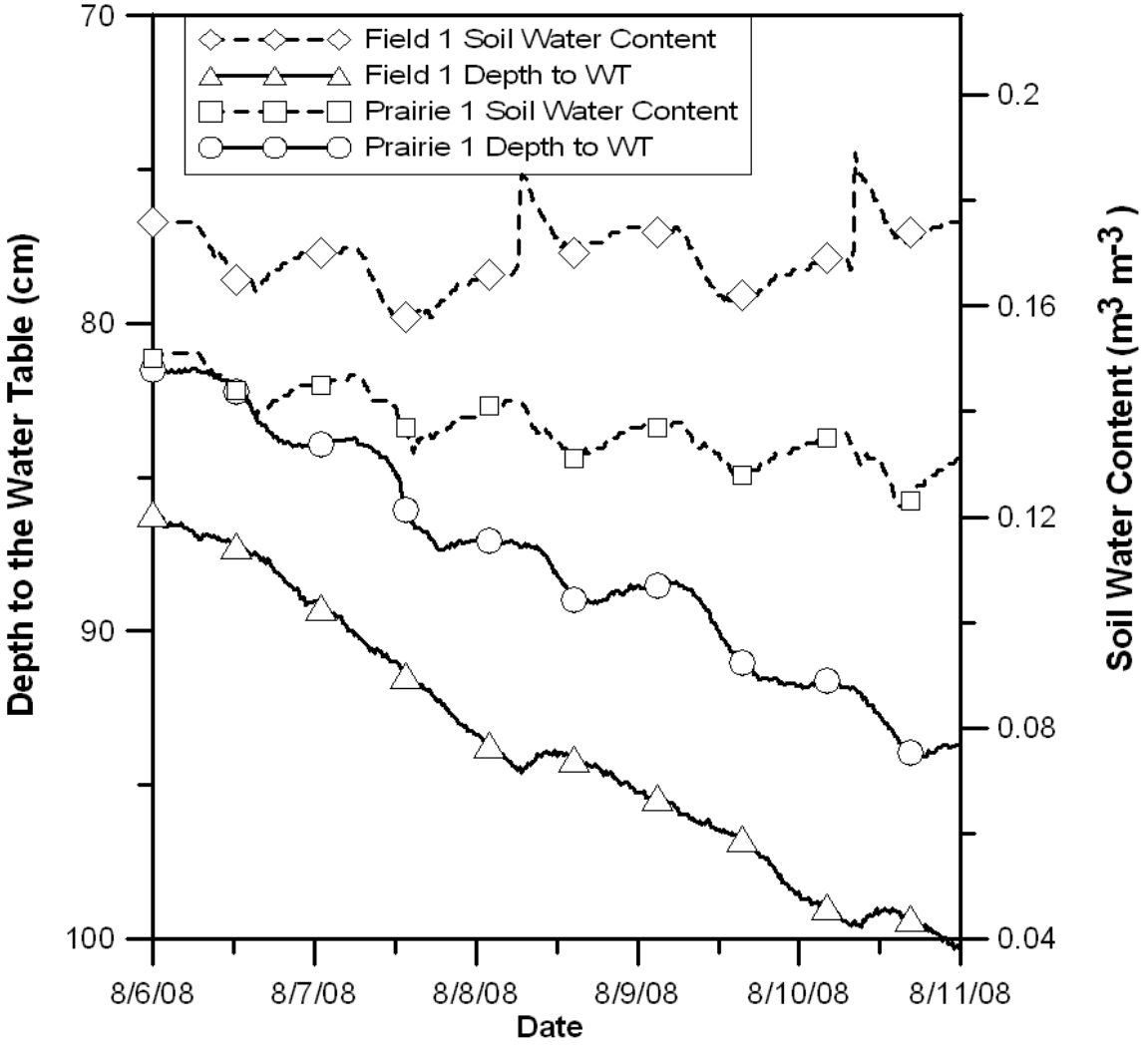

Fig. 4. Depth to groundwater and soil water content at two sites (irrigated agricultural and natural vegetation) near Westfield, WI.

Where groundwater was further from the surface, in the recharge area of the groundwatershed, responses to precipitation events were buffered by the greater depth of soil above the water table. There were limited noticeable responses of the water table to rain events less than 0.4 cm and we do not anticipate that natural vegetation will use water directly from groundwater.

Natural vegetation in the groundwater discharge area of the groundwatershed likely uses the same or similar amounts of groundwater as an irrigated crop. In the groundwater recharge area, however, where groundwater is further from the surface, irrigated agricultural crops have the potential to use a larger amount of water than dryland agricultural crops or

natural vegetation would. The natural vegetation at these sites will eventually stop transpiring during very dry periods to minimize stress on the plant. However, during the same periods irrigated agricultural crops will still receive enough water to continue transpiring at potential rates. The depths to water table differences are fundamental to the way each site responds to irrigation, precipitation, and vegetation type.