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Inspecting the Food–Water Nexus in the Ogallala Aquifer Region Using Satellite Remote Sensing Time Series

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Abstract and Figures

Agricultural production in the Great Plains provides a significant amount of food for the United States while contributing greatly to farm income in the region. However, recurrent droughts and expansion of crop production are increasing irrigation demand, leading to extensive pumping and attendant depletion of the Ogallala aquifer. In order to optimize water use, increase the sustainability of agricultural production, and identify best management practices, identification of food-water conflict hotspots in the Ogallala Aquifer Region (OAR) is necessary. We used satellite remote sensing time series of agricultural production (net primary production, NPP) and total water storage (TWS) to identify hotspots of food-water conflicts within the OAR and possible reasons behind these conflicts. Mean annual NPP (2001-2018) maps clearly showed intrusion of high NPP, aided by irrigation, into regions of historically low NPP (due to precipitation and temperature). Intrusion is particularly acute in the northern portion of OAR, where mean annual TWS (2002-2020) is high. The Oklahoma panhandle and Texas showed large decreasing TWS trends, which indicate the negative effects of current water demand for crop production on TWS. Nebraska demonstrated an increasing TWS trend even with a significant increase of NPP. A regional analysis of NPP and TWS can convey important information on current and potential conflicts in the food-water nexus and facilitate sustainable solutions. Methods developed in this study are relevant to other water-constrained agricultural production regions.

Map of study area [23].

Mean annual average total...

Mean annual net primary...

Net primary production (NPP...

Mean annual total water storage...

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Inspecting the Food–Water Nexus in the Ogallala Aquifer Region Using Satellite Remote Sensing Time Series

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Keywords: remote sensing; Ogallala aquifer; food–energy–water (FEW) nexus

1. Introduction

Food, energy, and water are basic needs of each human being and thus the whole of soci These resources are also highly intertwined, resulting in the need to study them from an integrat standpoint. The food–energy–water (FEW) nexus approach has emerged as a powerful ontologi tool for understanding and sustainably managing these resources [1,2]. The challenges to food, wat and energy from the continued rise of global population and associated rates of consumption a compounded by the political, economic, and social consequences of climate change. The forecast increased threats to these resources highlights an increasing necessity to study the FEW nexus in integrated manner. Although studies involving in situ observations are illuminative for the FI nexus [3,4], government funding for resource monitoring is limited and faces gradual reduction a re-prioritization at the local and national level.

Remote sensing provides consistent and region-wide observations that can guide policy mak and decisions in support of in situ observations. Various remote sensing products can be used study food, energy, and water at the regional scale. For example, the U.S. Department of Agricultur

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