National Irrigated Lands Mapping via an Automated Remote Sensing Based Methodology

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1. INTRODUCTION

According to the U.S. Department of Agriculture (USDA) 2002 Census of Agriculture (published every five years by the National Agricultural Statistics Service), more than 55 million acres in the United States are irrigated (USDA 2002). However, there is no consistent, upto-date national-level map of irrigated lands. Knowledge of the distribution and location of irrigated lands can play a role in multiple waterresource management decisions. This information can factor into hydrologic research questions and operational decisions related to crop water use, strategic planning, water rights, irrigation system performance diagnostics, and water supply impact assessment.

Mapping all of the irrigated areas across the conterminous United States is challenging due to the geographic extent of the study area (over 2.9 million square miles) and the heterogeneity of the agricultural landscape. Some spatially-specific irrigation information is available, but it is not of adequate spatial detail, not up-to-date, not consistently available across all of the conterminous states, or a combination of these factors. Although several state-level mapping activities have delineated irrigated areas, they were not consistent in their classification methods or production dates.

The goal of this project is to develop a robust, consistent, and efficient methodology to identify irrigated lands across the United States based on remotely sensed and other geospatial input data generated in an automated and repeatable fashion.

2. METHODS

Satellite remote sensing offers objective synoptic sources of biophysical measures for geospatial information related to water use and management, including the location and distribution of irrigated areas. This methodology incorporated three data sources: satellite-derived vegetation index (VI) data, USDA county-level irrigation summary statistics for 2002, and general land cover information. The satellite data, collected by the Moderate Resolution Imaging Spectroradiometer (MODIS) aboard the Earth Observing System Terra platform (Justice and Townshend 2002), provided a source for a measurement of the annual peak of growing season productivity at a 250-m spatial resolution. The peak VI was calculated for four years (2001-2004) for the derivation of irrigated areas in the United States. In an automated classification environment (ArcView Avenue), the 2002 county statistics (that is, number of irrigated acres) provided the criteria for dynamically identifying and selecting the number of cells with the highest annual peak MODIS VI within the appropriate land cover categories. The land cover information was contributed by the 2001 National Land Cover Database (Homer 2004). Areas that were not classified as either pasture/hay or cultivated crops were eliminated from consideration by the model.

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3. RESULTS

A map of irrigated lands resulting from the above described model is shown in Figure 1. A comprehensive evaluation of the initial irrigated lands classification is underway and will incorporate several comparison data sources because there is no single national irrigated lands map available at this scale.

A recent evaluation focused on the state of Nebraska utilized a detailed 2005 Landsat-derived land use map containing an irrigated land use category (Dappen et al. 2007). The overall classification accuracy of the irrigation layer in the 2005 Nebraska land use map was 93.6 percent based on comparisons to 3,375 field reference points. Comparisons between the Nebraska data and the 2001-2004 MODIS-based irrigated area data for Nebraska showed agreement to be 88.7 percent for 2001, 90.2 percent for 2002, 89.2 percent for 2003, and 89.2 percent for 2004. Figure 2 shows the agreement and disagreement between the two irrigation data sets. A certain amount of disagreement may be related to the inherent differences in the spatial resolutions of the two irrigated area maps.

Further evaluation of the MODIS-derived irrigated lands map is planned and will include comparisons with existing state or regional land use and land cover maps containing irrigated crop classes and comparisons with geospatial irrigation well location data.

4. REFERENCES

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Figure 1. Map of irrigated lands for the conterminous United States modeled from MODIS 250–m peak VI, 2001 National Land Cover Database, and the 2002 Census of Agriculture.



Figure 2. Agreement (in green) and disagreement (in blue and red) between the irrigation layer in the 2005 Nebraska land use map (derived from Landsat) and the MODIS-derived irrigated area model.