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Automated Detection of On-Farm Irrigation Reservoirs in Two Critical Groundwater Regions of Arkansas:

A Necessary Precursor for Conjunctive Water Management

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ABSTRACT

In eastern Arkansas, the use of surface water for crop irrigation is steadily increasing in response to declining aquifers. Effective conjunctive water management requires accurate and timely information on the locations, sizes, and numbers of on-farm irrigation reservoirs. A method for remotely locating and characterizing on-farm reservoirs was developed using relative elevation and near-infrared imagery. With 62% accuracy, the method automatically identified 429 irrigation reservoirs within a 1.9-Mha area in less than an hour using an off-the-shelf laptop. Reservoirs not accurately identified (i.e., false negatives) were caused by the presence of vegetation or turbidity within the reservoirs. There were no false positive detections. This approach for identifying elevated reservoirs is applicable across the Mississippi Alluvial Plain (MAP) that encompasses over 4-Mha of irrigated cropland and other agricultural areas having low-relief.

KEYWORDS

ArcGIS Pro Model Builder, Automated Reservoir Detection, Conjunctive Water Management, Topographic Modeling, Waterbody Classification

INTRODUCTION

The Mississippi River Valley Alluvial Aquifer (MRVAA) provides 90% of the irrigation water applied to crops in the Mississippi Alluvial Plain (MAP) (Leslie et al., 2022). The aquifer has been over-exploited for decades (Bedinger et al., 1964; Clark et al., 2011; 2013; Vories & Evett, 2014). In order to capture precipitation/runoff and reduce groundwater withdrawals, irrigation reservoirs are being

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constructed on farms throughout the MAP (Evett et al., 2003). Additionally, in central Arkansas, two large surface water diversion projects will use on-farm reservoirs to store water removed from the White River and the Arkansas River to offset groundwater pumping (USACE, 1999; 2007).

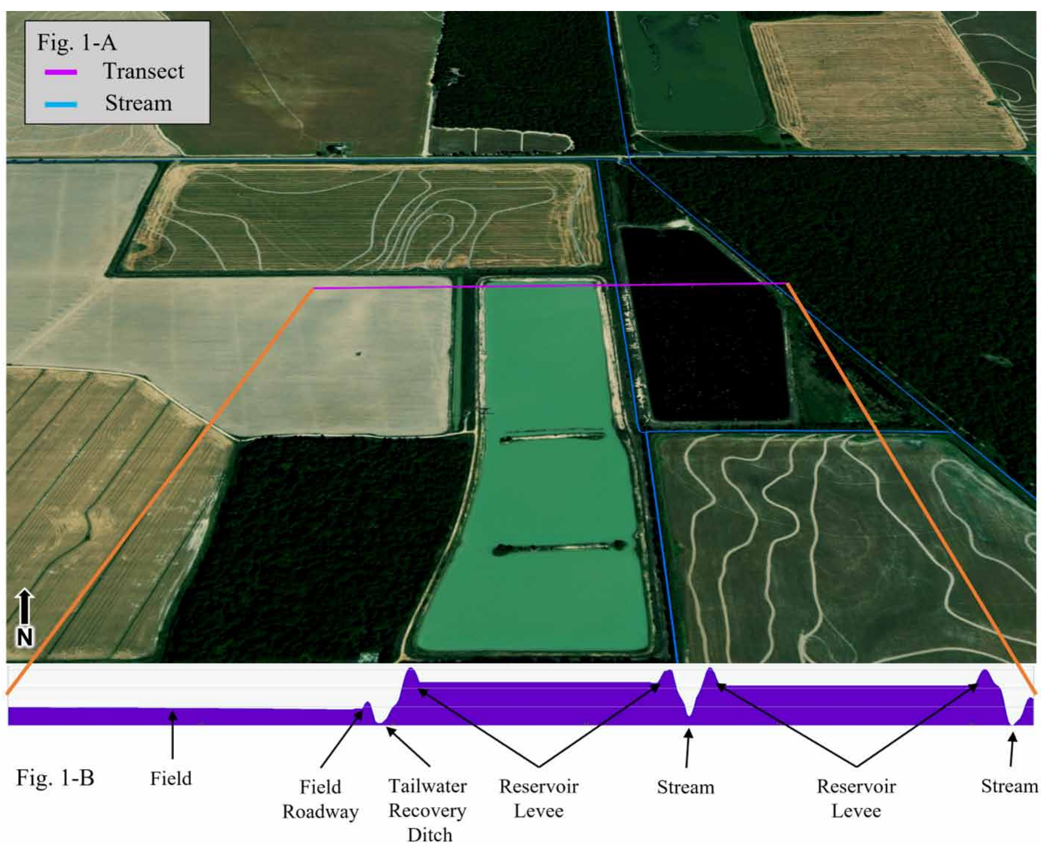
These on-farm reservoirs can be stand-alone structures or may be part of more complex systems having a tailwater recovery 'pit' or 'ditch' to capture runoff (Figure 1). In both cases, the reservoirs are generally symmetrical (e.g., square, rectangular, triangular), relatively compact (i.e., small perimeter-to-surface area ratio), and surrounded by raised earthen levees (Yaeger et al., 2018).

Strategies to conjunctively manage surface and ground water resources (Kovacs et al., 2016; Singh et al., 2016) have been adopted in Arkansas (ANRC, 2014; 2016; 2017; 2019), Mississippi (YMD, 2006), Louisiana (E&E INC, 2011), and Missouri (MDNR, 2020). As a result, accurate and up-to-date information on irrigation reservoirs is necessary to allow resource managers and policymakers to (a) assess how existing reservoirs may impact groundwater demand, (b) determine where surface waters could support additional reservoir(s), (c) estimate maintenance costs and life expectancies of existing reservoir infrastructure, and (d) determine carrying capacity of reservoir area per watershed area.

Figure 1 shows examples of (A) two on-farm irrigation reservoirs in Eastern Arkansas that receive water pumped from streams and/or a tailwater recovery ditch (center) and (B) corresponding elevation profile. Note the western reservoir's high turbidity in contrast to the eastern reservoir.

The construction of reservoirs in the MAP may occur solely at the expense of farmers and/or landowners but more commonly occurs with assistance from federal and state agencies (Czarnecki et al., 2024; King, 2021). In Arkansas, approximately $45 million were awarded by the USDA Natural

Figure 1. Irrigation reservoirs in eastern arkansas and their corresponding elevation profiles



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