



StoryMaps for Environmental Communication: Tools for Participatory Water Research in Cimarron County, OK and Beyond



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INTRODUCTION

Can geovisualization be used to enhance environmental communication? In this poster, we seek to answer this question by presenting the results of a participatory research project on complex issues involving groundwater depletion in Cimarron County, OK, specifically, and throughout the High Plains Aquifer (HPA) region, more generally. The student-led research project, part of a larger project on agroecosystem resilience during periods of drought, culminated in the production of two StoryMaps that address the challenges diverse stakeholders in Cimarron County and the HPA region face. We argue that using GIS and, more specifically, StoryMaps, to present these diverse issues surrounding groundwater depletion over broad spatial and temporal scales can help educate communities on groundwater management and the environmental risks faced throughout the study area.

STUDY AREA

Cimarron County, OK is within the High Plains Aquifer System (HPA) (Fig. 1), which spans 237 counties in eight states. Though largely within a semi-arid region, the area is a major agriculture producer for the nation. However, cyclic drought (such as the 1930s Dust Bowl) and reliance on groundwater resources from the Ogallala, the largest aquifer in the HPA, concerns scientists and other stakeholders. Cimarron County has been a focal point for these pressing environmental issue.

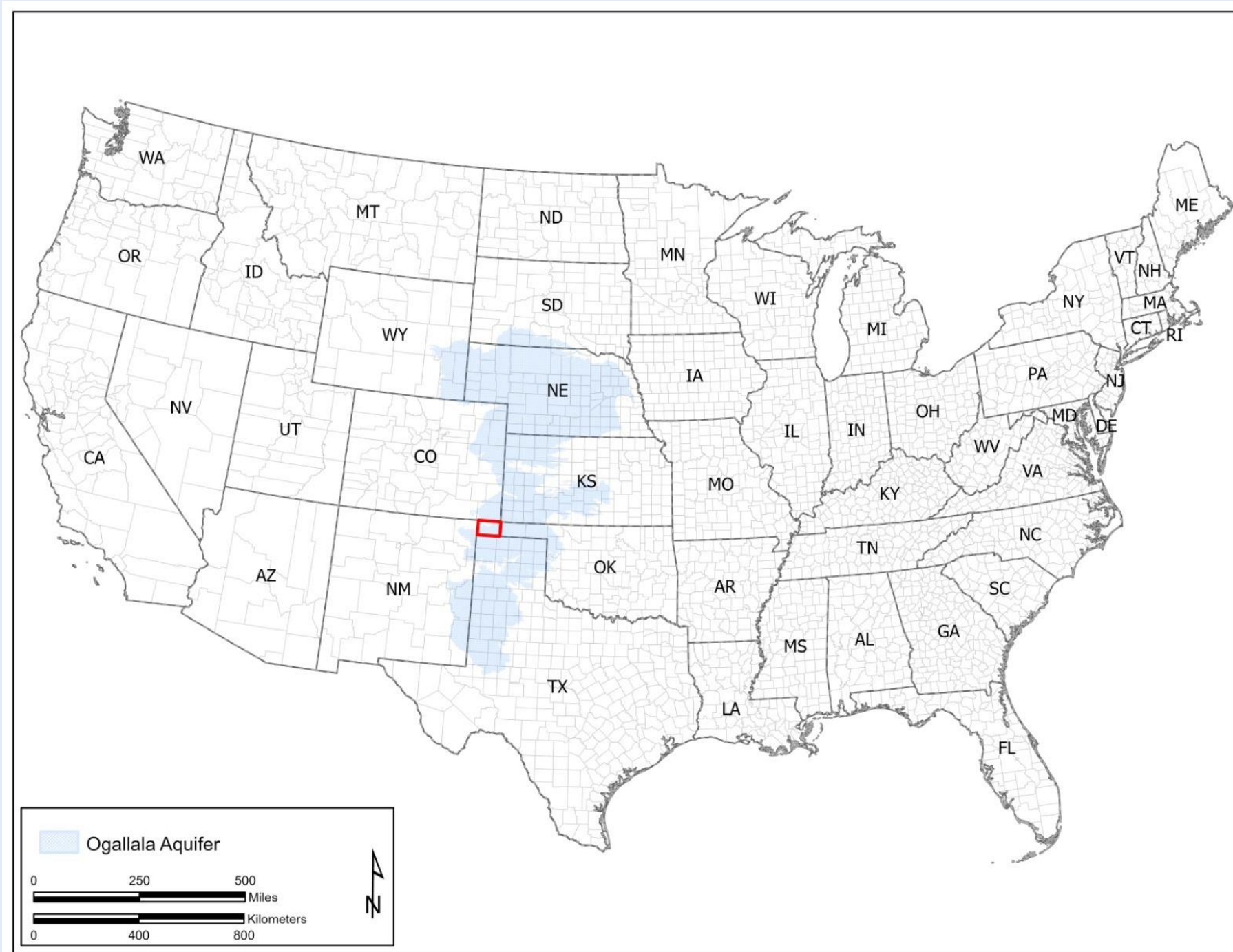


Fig. 1. High Plains Aquifer, often called Ogallala Aquifer. Map by Authors.

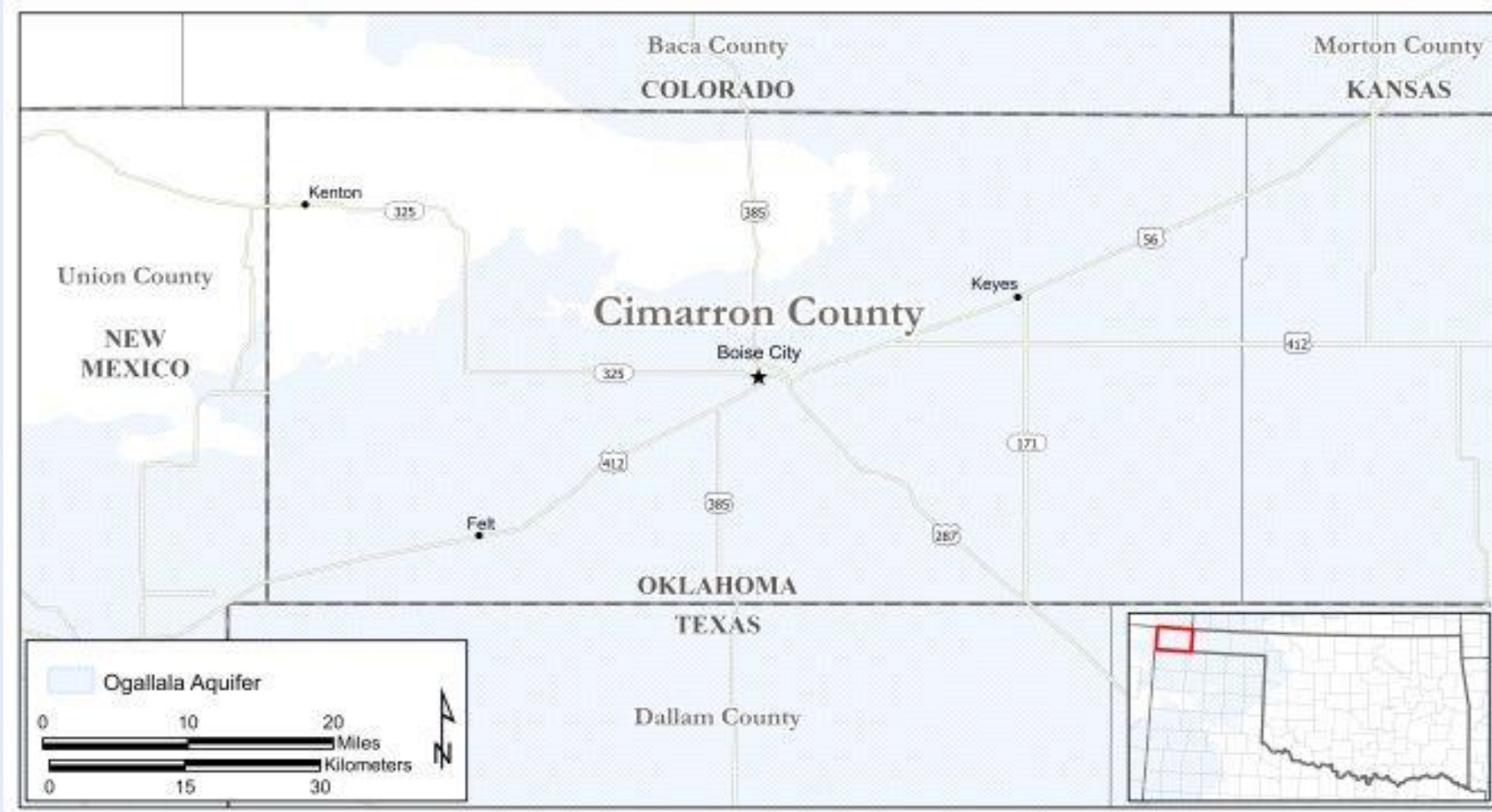


Fig. 2. Cimarron County, Oklahoma. Map from Vadjunec et al. 2021.

Cimarron County is the western-most county in Oklahoma (Fig. 2). It has a semi-arid climate with beautiful open spaces predominated by shortgrass prairie. It is also home to the highest point in Oklahoma, Black Mesa. Cimarron County is part of the Southern High Plains, has an agricultural-based economy, and is sparsely populated, home to 2,252 individuals, with a population density of 1.3 people/mi² (Census 2023). The main agriculture-related economic activities are cattle ranching, with 63% (691,407 ac.) of agricultural lands land dedicated to pastureland, and farming, with 37% (406,065 ac.) of agricultural lands in cropland (NASS 2017).

Students were challenged with the task of presenting complex agroecological and hydrogeological issues to a diverse audience comprised of many stakeholders. Ultimately, geovisualization techniques using StoryMaps proved to be an effective method to communicate these environmental issues with the various stakeholders. Fig. 3 illustrates our process of environmental communication through geovisualization techniques.

Below are examples of the diverse array of information available for the users in these StoryMaps (Fig. 4 and 5):

OGALLALA

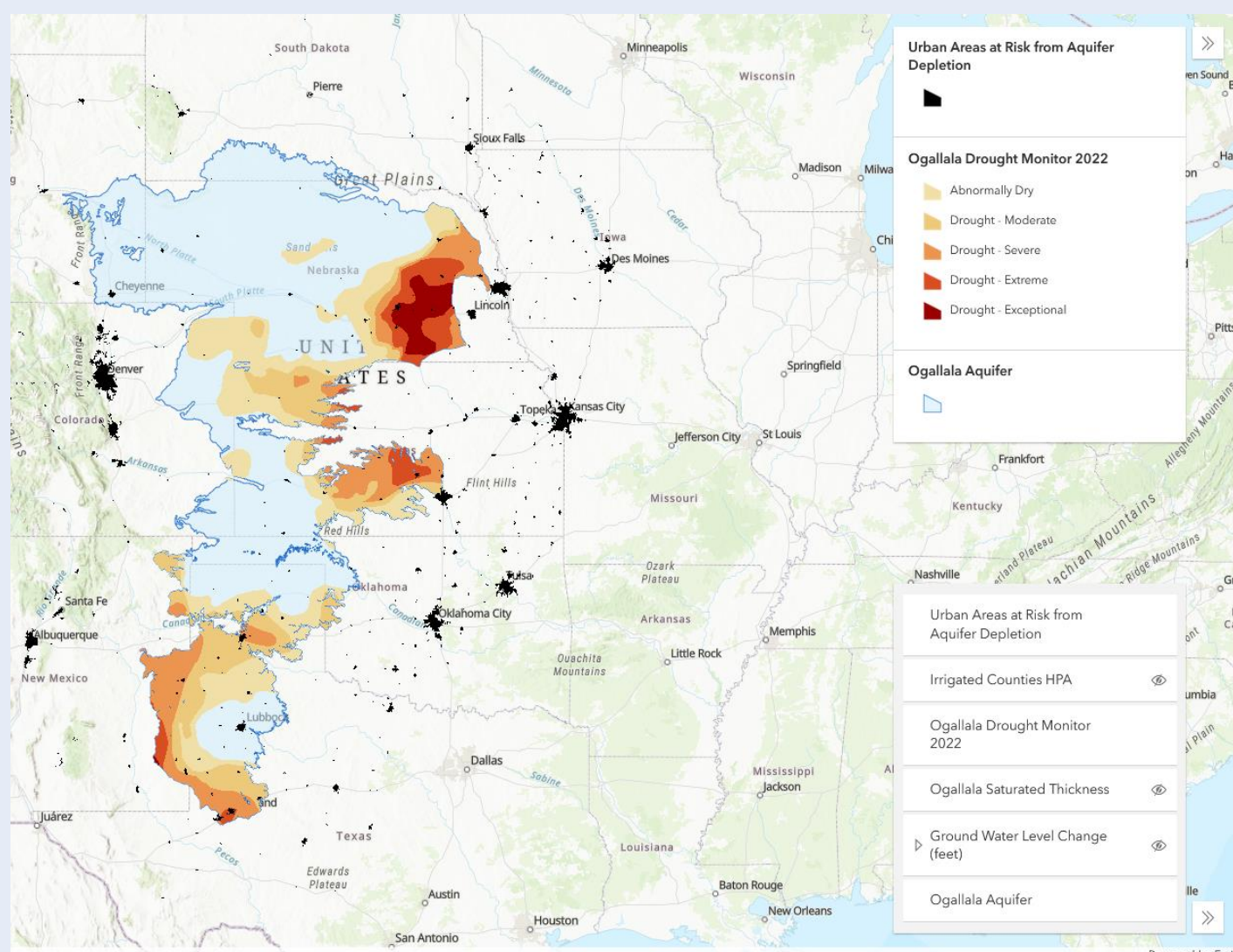


Fig. 4a. An example of an interactive web map from the Ogallala StoryMap enabling users to explore urban areas at risk of drawdown and areas impacted by drought.

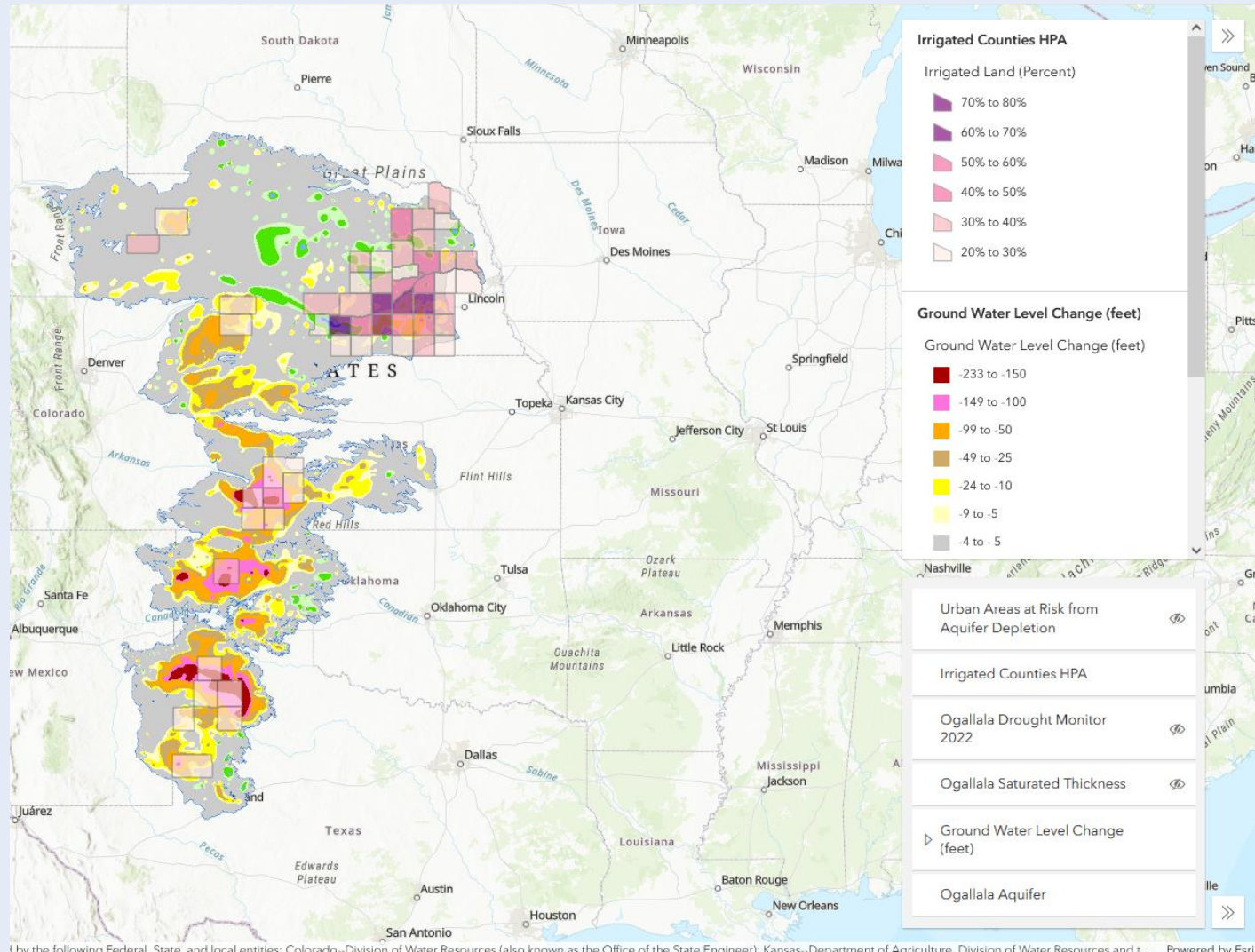


Fig. 4b. An example of an interactive web map showing county-level irrigation percentages overlain with groundwater levels, enabling users to visualize relationships between irrigation and drawdown.

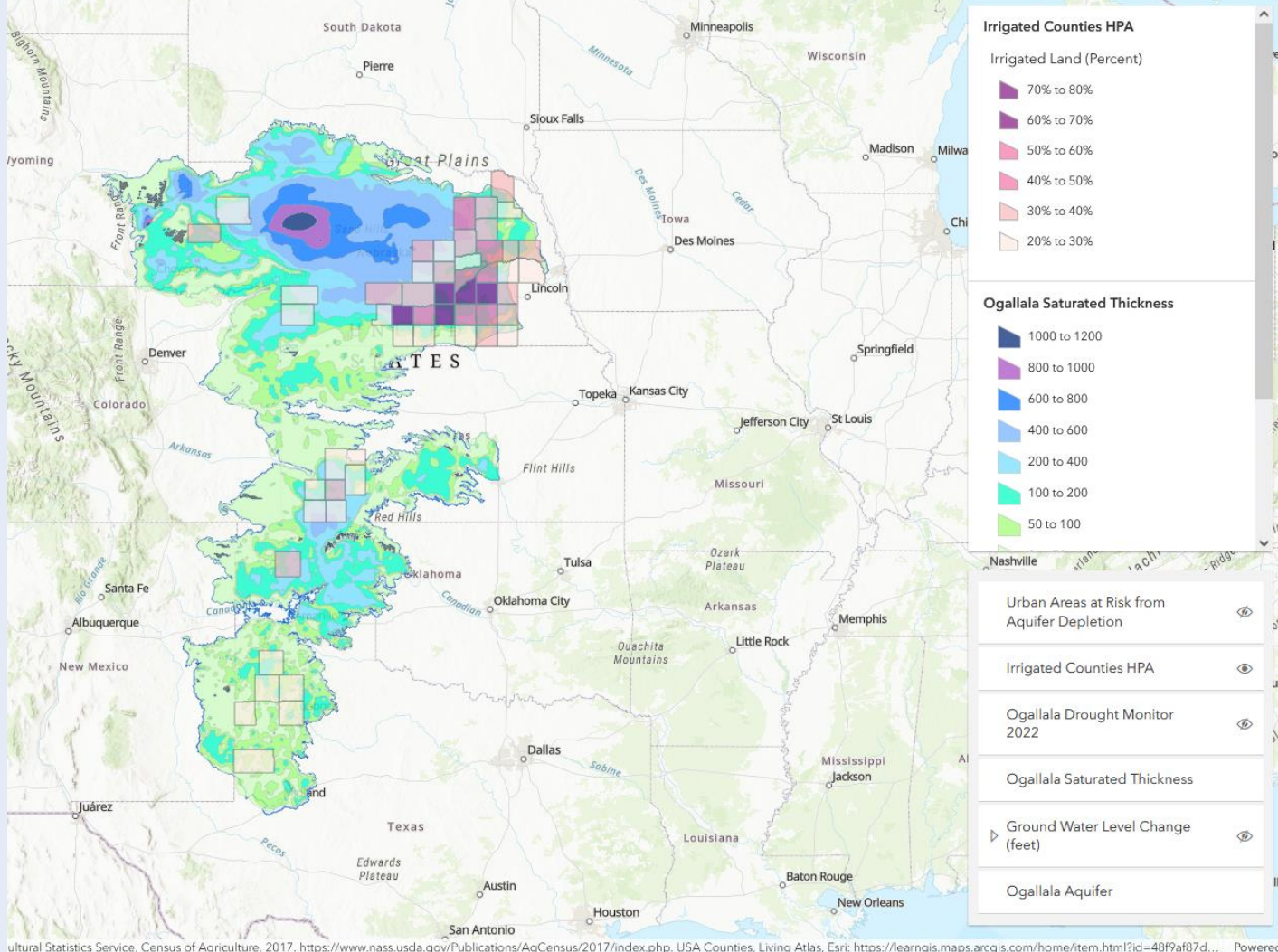


Fig. 4c. Similarly, county-level irrigation rates can be explored in conjunction with the Ogallala's saturated thickness, allowing stakeholders to visualize complex relationships of land use and hydrogeology.

RESULTS

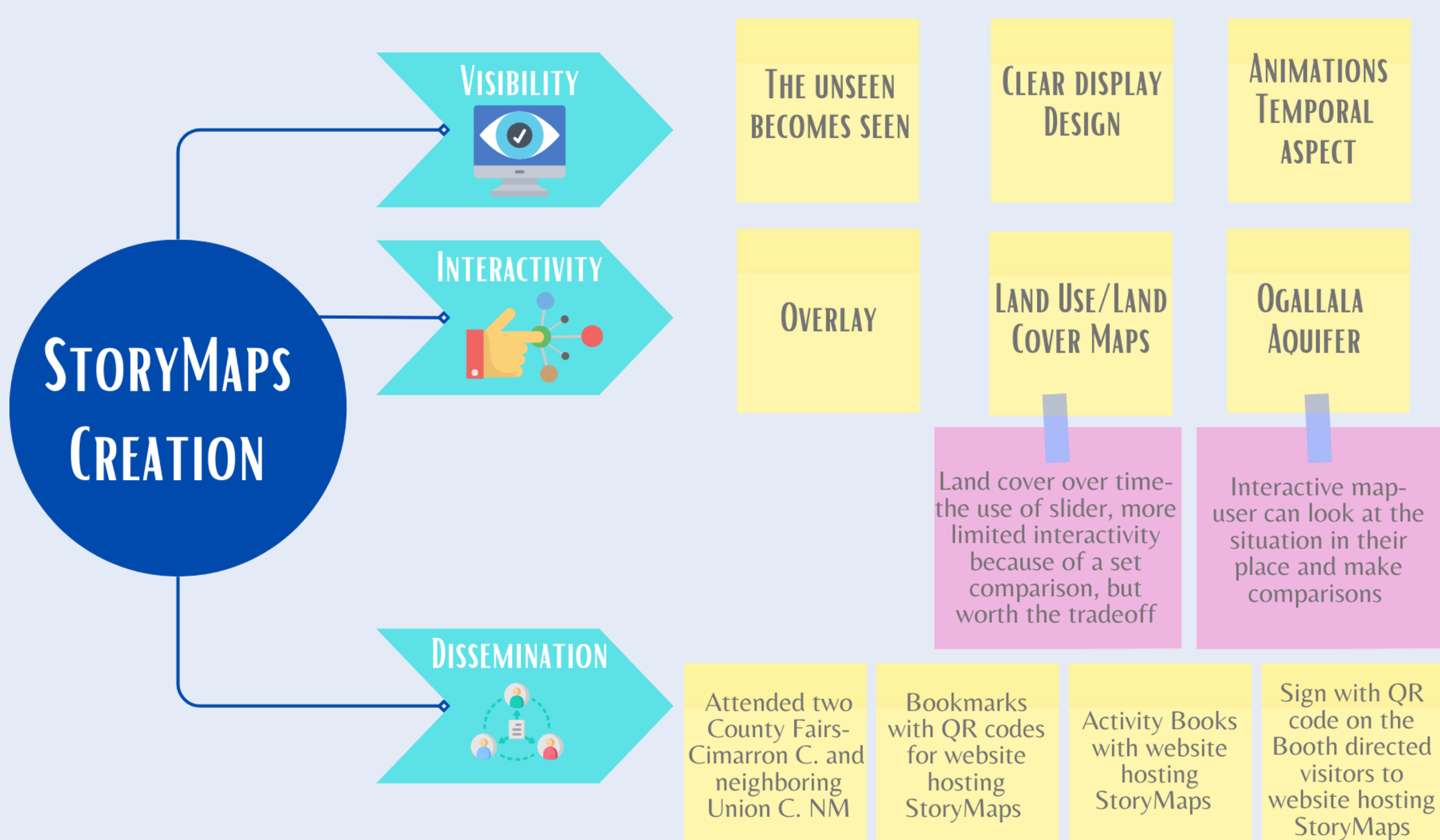


Fig. 3. A diagrammatic representation of the StoryMaps creation process. Source: Authors.

LAND USE & LAND COVER CHANGE

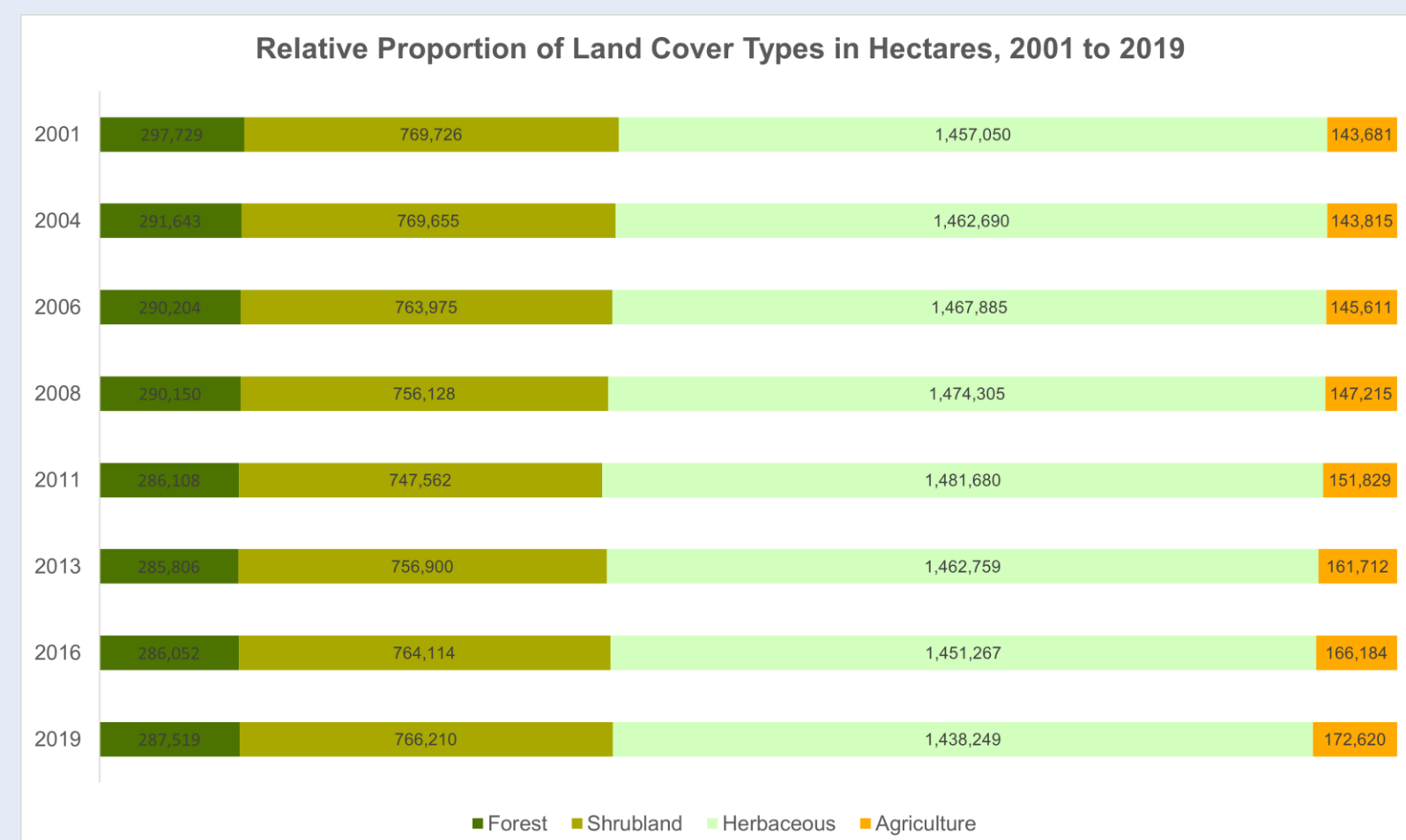


Fig. 5a: Land cover change in the three county ARID study area. NLCD data were reclassified into four principal land cover types: forest, shrubland, herbaceous, and agriculture. In the 19-year period displayed in the graph, there is a slight increase in agricultural areas. Graph based on Fagin et al. 2016 and updated with additional NLCD data, including addition of Las Animas County.

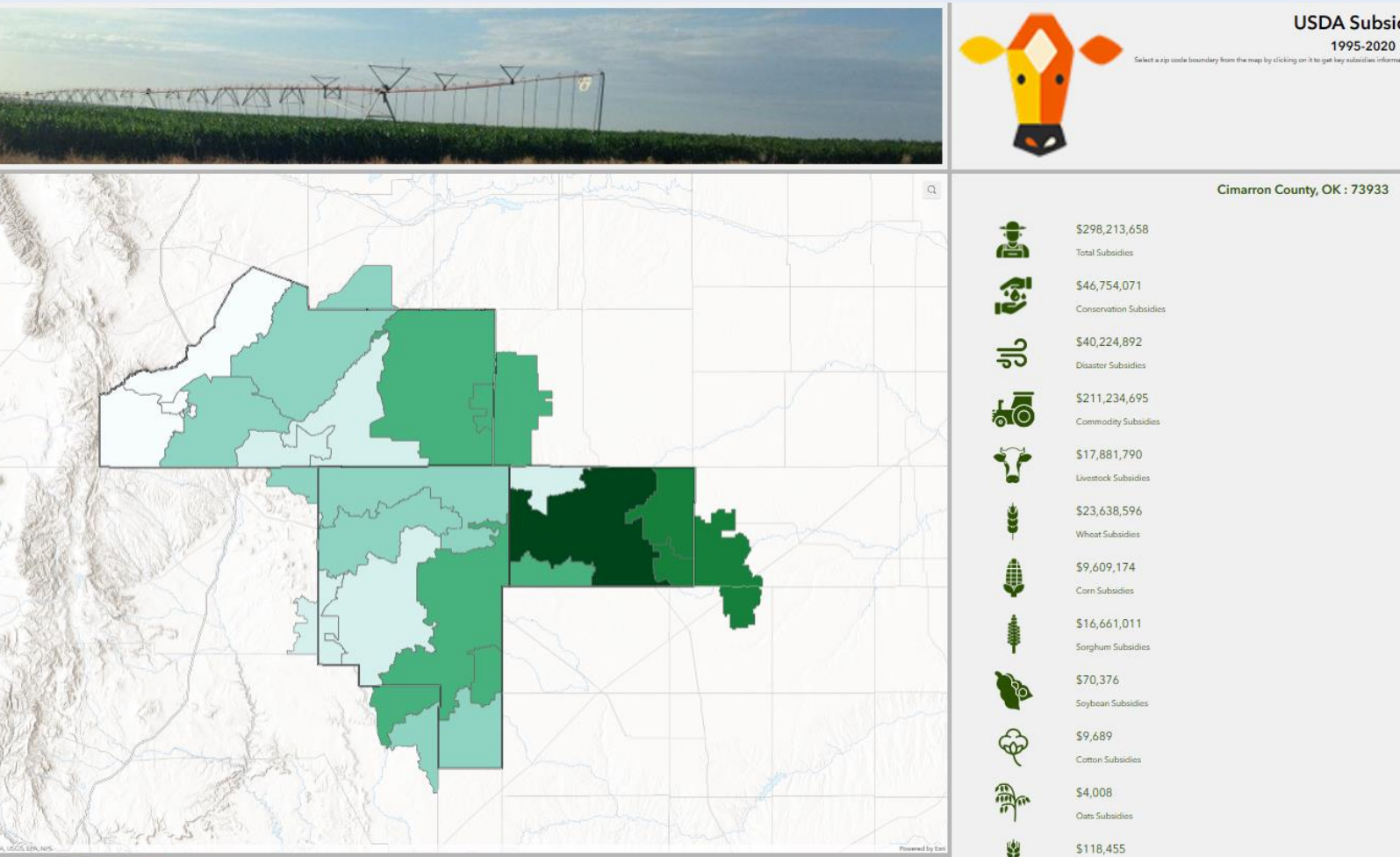


Fig. 5c: Custom Experience Builder app showing USDA subsidy data. Users can click on a zip code to see the types and amounts of subsidies received in each zip code from 1995 to 2020. When viewed in conjunction with other data, such as land use/land cover change, a complex picture begins to emerge.

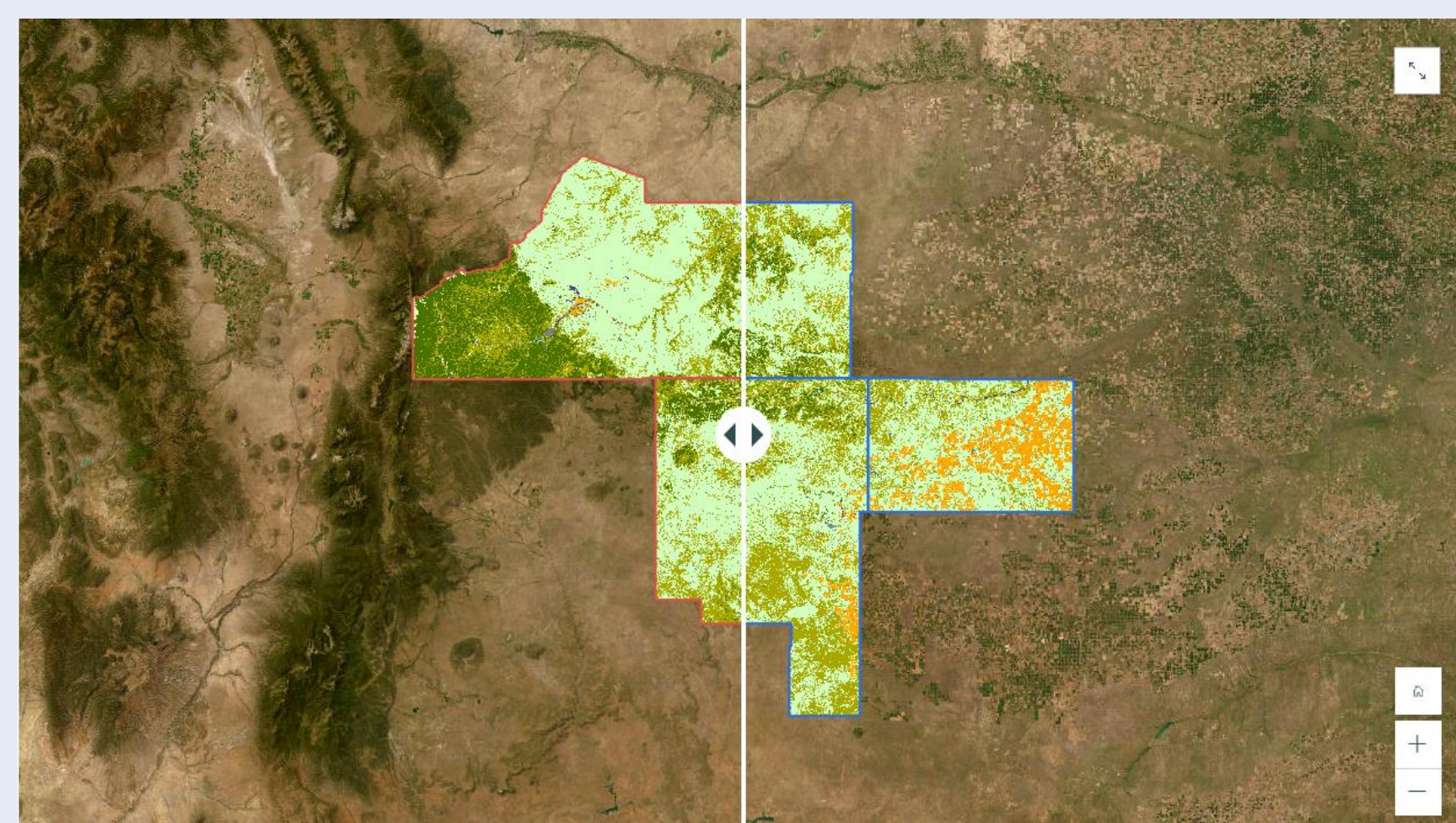


Fig. 5b: Reclassified NLCD land cover types from 2001 (red/left) and 2011 (blue/right), a period corresponding to intense drought. Notable changes the slider enables users to geovisualize include loss of woody vegetation in southwestern and northern Las Animas County and increases in agriculture, particularly center pivot irrigation, in Cimarron County. Based on previous work by Fagin et al. 2016.

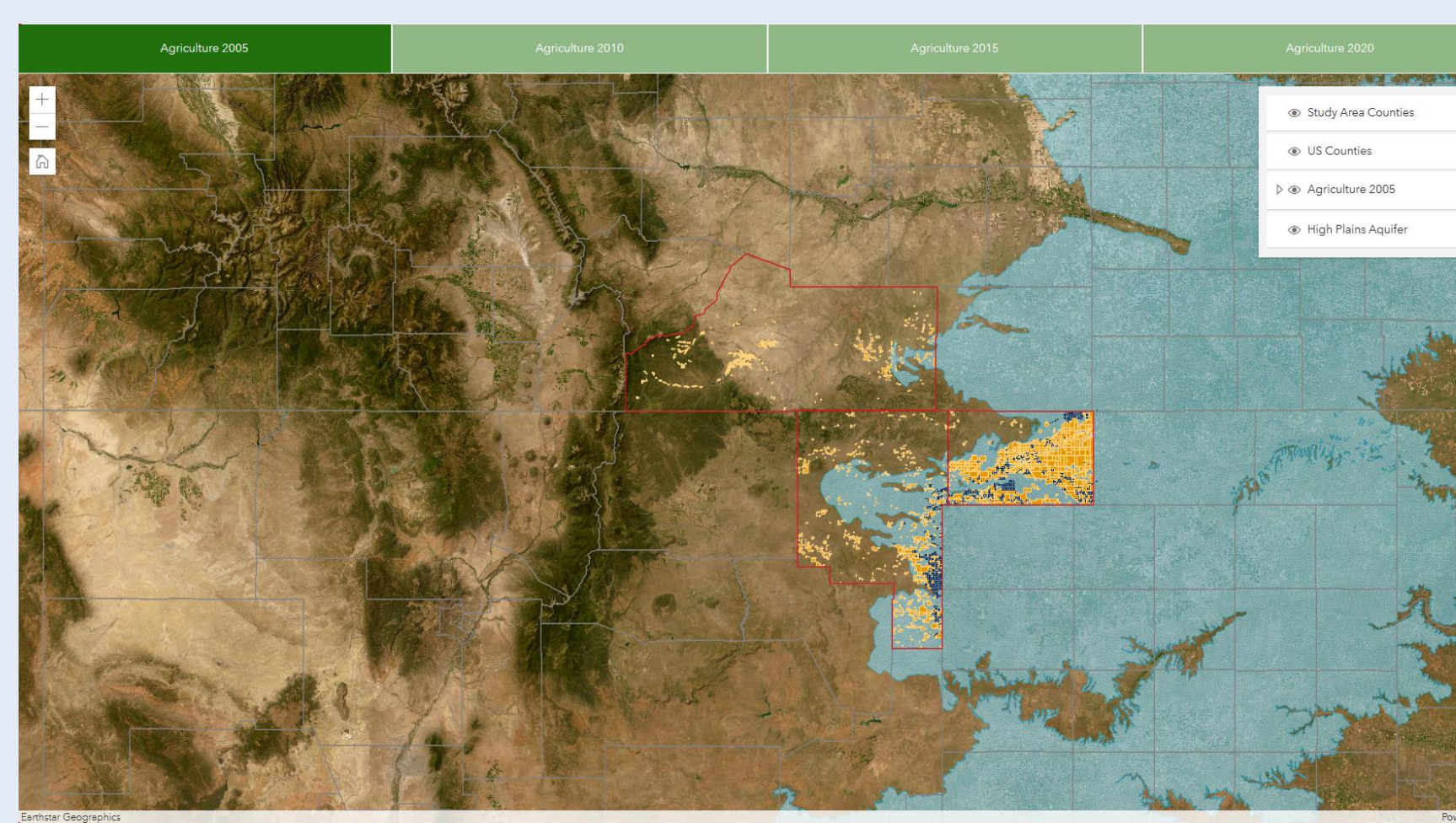


Fig. 5d: Interactive web maps showing agricultural change from 2005 to 2020. Each map is dynamically linked and displayed using a tab interface. Users can click on each tab to see the agricultural change at the exact same scale and extent of the other maps. Data to be presented in Vadjunec et al. Forthcoming.



Fig. 5e: Other content in the StoryMap includes photos from the study area to provide context for individuals familiar with the region. (A) farm with center pivot irrigation; (B) wild burros; (C) center pivot irrigation; and (D) cattle.

WHAT IS ENVIRONMENTAL COMMUNICATION?

Environmental communication is a multidisciplinary field that “describes the many ways and the forums in which citizens, corporations, public officials, journalists, and environmental groups raise concerns and attempt to influence the important decisions that affect our planet” (Cox 2013: 11). Some environmental issues and their dynamics, such as groundwater, are invisible to the everyday life and sometimes hard to conceptualize. Therefore, visualization tools allow the public to “see” the invisible and vital environmental issues, their current situation, and to raise awareness (Kuchinskaya 2018). Improving environmental communication at a local level becomes a necessity when presenting environmental issues (Vadjunec et al. 2018: 971), such as the HPA's depletion.

WHAT IS GEOVISUALIZATION?

Geovisualization is the visual representation of geospatial data “to make spatial context and problems visible” (Marzouki et al. 2017: 3). Geovisualization techniques aim to achieve wider data distribution and “non-proprietary or “open” formats for geospatial data”(Smith et al. 2013: 4). They can be used to facilitate education on groundwater resource management and inform the decision-making process to make the invisible visible. Animating geospatial data to convey spatial and temporal change illuminates those changes worthy of note (Smith et al 2013:13-14) relevant to the complex issue of groundwater drawdown in the HPA.

JUSTIFICATION/METHODS

The causes and consequences of aquifer drawdown in Cimarron County and the broader HPA region are not readily observable. Instead, multiple factors, such as land use/land cover change, cyclic drought, climate change, and formal and informal governance regimes can influence human activities that drive groundwater exploitation. For instance, corn subsidies, driven by demands for ethanol, coupled with environmental subsidies to improve irrigation efficiency, can inadvertently lead to the proliferation of center pivot irrigation systems and resulting groundwater exploitation. Additionally, cyclic drought can put pressure on agriculturalist seeking to maximize yields during drier than normal periods, while international commodity markets can drive the crops they grow.

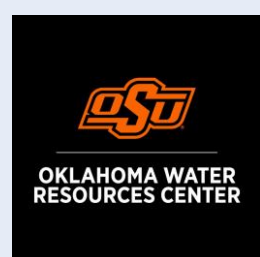
As part of the mixed methods participatory research study in Cimarron County, Oklahoma, our team (comprised of five students and three scientists) created two StoryMaps, "The Ogallala Aquifer" and "Land Use & Land Cover Change in the High Plains." Throughout the process of StoryMap creation, the student researchers learned about the complex issues facing groundwater resources and participatory research methods through hands-on fieldwork, ethnographic studies, and geospatial analysis involving a semi-arid, agroecological region where cyclical drought, land-use/land cover dynamics, and groundwater utilization converge.

CONCLUSION

Our research demonstrates that environmental communication can benefit from geovisualization techniques. StoryMaps enabled us to display multi-faceted, interrelated, quantitative environmental data and create an accompanying narrative to show the complex causes and consequences of aquifer drawdown in Cimarron County, OK and the broader HPA region. While not all environmental risks can be accounted for, major contributors to Ogallala groundwater depletion, such as land use & land cover change and formal governance structure (e.g. crop and disaster subsidies), can be explored through the combination of interactive maps, other multi-media, and narrative on the complex spatial and temporal issues facing the aquifer. Additionally, the StoryMaps are publicly available and can be accessed not only by stakeholders in Cimarron County and the larger HPA region, but by others interested in these environmental issues. The use of StoryMaps in this participatory study benefitted student researchers and community stakeholders, alike, and effectively made the unseen visible.

ACKNOWLEDGEMENTS

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STORYMAPS



Land Use & Land Cover Change and Drought



The Ogallala Aquifer and its Importance

REFERENCES



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