Pre-Proposal Application Form
2021–2022 TWRI Graduate Student Research Programs

Please complete all parts of this Pre-Proposal Application Form to be considered for the Texas Water Resources Institute (TWRI) Graduate Student Research Programs. Pre-proposals should be at least 11-point Times New Roman font with 1-inch margins. Pre-proposals must be received electronically by **11:59 p.m. CDT, November 23, 2020**, to be considered.

The completed Pre-Proposal Application Form must be e-mailed as an electronic document (Microsoft Word) to Danielle Kalisek at Danielle.Kalisek@ag.tamu.edu. The application package is **limited to 3 pages** and must include items 1 through 9 below. You do not have to keep the instructions within your application form but ensure that each section is titled accordingly and the required items 1 through 9 are addressed. *Applications with Basic Information beyond the 3-page limit **will not** be considered in the review process.* The Other Required Information 10-11 is not included in the 3-page limit.

Basic Information:

1. **Title of pre-proposal.**
Land-Use/Land-Cover and Demographic Changes in the Ogallala Aquifer Region: Past and Future Implications

2. **Student name, contact information (email and phone number), university, department, degree being pursued as well as degree starting year and expected year of graduation.**
Edward C Rhodes, rhodes@tamu.edu, 940-886-6130 (Cell)
Texas A&M University/Department of Ecology and Conservation Biology/PhD.
Started January 2021, anticipated graduation May 2024

3. **Faculty advisor or committee chair name, title, contact information (email and phone number), university and department.**
Amanda Ray, Academic Advisor III, amanda.ray@tamu.edu, 979-862-6470, Texas A&M University, Department of Ecology and Conservation Biology
Humberto Perroto-Baldivieso, PhD., Associate Professor, humberto.perotto@tamuk.edu, (361) 593-3977, Texas A&M University – Kingsville, Caesar Kleberg Wildlife Research Institute, Department of Rangeland and Wildlife Sciences

4. **Which program(s) are you applying for (only select one option)? In addition, please also indicate, if applicable, if you previously received funds from Mills or USGS, or if you are not eligible for Mills due to eligibility restrictions.**

_X_ Mills Scholarship Program (Texas A&M, Galveston or Qatar only; tuition only)

___ USGS Research Program (any Texas university; categorical funds and/or tuition)

___ Either program will fit my needs and eligibility

5. **Have you received either the Mills Scholarship or USGS Research Program funds before? If so, please indicate which source and the year.**
I have not received funds from either of these programs.

6. **Would these funds be initiating new research or supporting ongoing research? If ongoing, please briefly explain where you are at in the research and project timeline, funding source, funding amount (please differentiate between federal and nonfederal), and project start and end dates.**
These funds will be used to support new research that is part of a larger ongoing project. The project is a collaborative effort between the Texas Water Resources Institute, Texas A&M AgriLife Research – El Paso, and the Caesar Kleberg Wildlife Research Institute in Kingsville. The El Paso center is conducting long-term groundwater modeling and crop use on the Ogallala aquifer region, while I will be looking at long-term land use trends and quantifying the fragmentation of rangelands over a

seventy-year period. I have currently been working on a literature review of the problem area and research topic.

7. **Abstract: Please provide 200 words or less about your proposed research problem, methods and objectives, and describe how your research will address the research priorities.**

The Ogallala aquifer is the largest freshwater aquifer in North America and one of the largest in the world, supporting approximately 30% of all crop and animal production in the United States, and is critical to the global food supply chain. However, water is being depleted at a higher rate than can naturally recharge. In many areas of the aquifer, the water supply has been reduced by more than 40-75% since pre-development. Additionally, up to 25% of this region's soils are not able to support cropland production without irrigation, making range and pastureland the primary future use on these soils. Going forward, rangeland management, ecosystem health, and soil health will have increased importance for the delivery of critical ecosystem services. The specific objectives of this project are to 1) address the role that rangeland management must play to provide critical ecosystem services on abandoned farmland as groundwater resources are depleted; 2) quantify historical land use and land cover trends within the Ogallala region from the mid-1950s to present, 3) analyze the potential effects of land use on surface water quality on the Texas High Plains, and 4) estimate future water needs based upon projected future land use and population data.

8. **Description of your research proposed research, emphasizing how it will address water resources-related concerns (particularly how, if possible, it will benefit Texas), including**:

   a. *Statement of critical regional or state water problem.* Describe how your research will address RFP research priorities and explain the need for the project, who wants it and why.

      The Ogallala aquifer, underlying approximately 450,660 km^2, is the most heavily-tapped aquifer in North America, accounting for 15% of all groundwater withdrawals in the Conterminous United States (Lovelace et al. 2020). The aquifer lies under eight US states (Texas, Oklahoma, New Mexico, Nebraska, Kansas, Colorado, Wyoming, and South Dakota. Once referred to as the "Great American Desert," the Ogallala Aquifer Region was plagued by a boom-bust farming culture that expanded when rains were favorable and crashed during the dry years (Dennehy et al. 2002, Opie et al. 2018). The discovery this vast underground water resource led to the rapid expansion of irrigated farming, transforming this region into the "breadbasket of the world" (Opie et al. 2018). Today, it is estimated that over 45 billion liters per day are pumped from the Ogallala aquifer, 95% of which is used for irrigation (Lovelace et al. 2020). Total crop production in the Ogallala region accounts for approximately 10% of the entire crop value of the US (Smidt et al. 2016), making conservation of the aquifer crucial for the sustainability and security of the US and global food chain. At current water use rates, it is estimated that 24% of the Ogallala Aquifer Region is at risk of depletion by 2100 (Deines et al. 2020), threatening US agricultural production and drinking water resources. It is imperative that we understand the scope of this looming problem, including the historical patterns that have led to this current predicament, so that we can better address and manage the remaining water resources in the region, and foster further development of less water intensive agricultural practices that will still meet the US and world demand for food and fiber products.

   b. *Nature, scope and objectives of the research, including a timeline of activities.*

      Much research has been focused on more efficient irrigation systems and crops with greater water use efficiencies. However, in many cases, these new technologies actually promote an overall increase in total irrigated land surface, as greater efficiency means that the same amount of water can be used across a larger land area, resulting in more land conversion and a negligible savings in water use (Upendram and Peterson 2007, Pfeiffer and Lin 2014, Cruse et al. 2016, Grafton et al. 2018).

In this project, I will use historical aerial imagery from the 1950s through present, to map land use changes following the advent of center pivot irrigation in 1952. Through this, I will be able to correlate groundwater levels with the prevalence of center pivot irrigation systems in the Ogallala aquifer region of Texas, and how that has caused the fragmentation of rangelands and wildlife habitat in the region. Additionally, I will use land-use projections for the year 2100 from the EPA, to model future potential water needs for agriculture, and domestic urban use, to further illustrate to potential plight of this region if water resources are not conserved through alternative agricultural methods. Since there is very little surface water in this region, this data can be used to prepare for future water development projects such as lakes or pipelines. Project completion is anticipated to be in the spring of 2024.

c. *Methods, procedures and facilities.* Provide sufficient information to permit evaluation of the technical adequacy of the approach to satisfy the objectives.

   Historical aerial imagery has been obtained from the United States Department of Agriculture (USDA) Aerial Photography Field Office (APFO) for the 1950s, 1960s, 1970s, 1980s, and 1990s. Imagery from the year 2000-onward will be downloaded from the USDA National Agricultural Imagery Program (NAIP) via the Texas Natural Resources Information System (TNRIS) website. All historical imagery is taken from scans of black and white or color negative film and will be stitched and geo-referenced in ArcGIS Pro on a county-by-county basis. Imagery from 2000 and later is already in a geo-referenced digital format. All imagery will be classified for land cover types using object-oriented feature extraction in the ENVI software package. Cover types of particular interest includes cropland, rangeland, pasture, urban, and wooded areas. Accuracy of image classification will be measured using a random stratified sampling of each categorized class. Classifications are deemed acceptable if the overall accuracy is greater than 85%, and all individual classes (crop, range, etc) are greater than 70% (Thomlinson et al. 1999, Wulder et al. 2006, Rhodes et al. 2021). Future water needs for the year 2100 will be estimated based upon census projections, and the Integrated Climate and Land Use Scenarios (ICLUS) land use model for the year 2100 developed by the US Environmental Protection Agency. The ICLUS dataset has estimated land use categories based upon past growth and includes variables such as number of households, which can be used to estimate future domestic water needs.

d. *Statement of expected results or benefits.* Specify the type of information that is to be gained and how it will be used.
   This information can help us to better understand past land use trends in relation to technological advances in irrigation and crop efficiency and help us to predict future land and water use needs in a region where the water supply is rapidly declining. Additionally, this will show us the effects of these practices have on the fragmentation of naturally occurring rangeland resources and their associated wildlife habitat.

9. Intended career path you anticipate pursuing.

   I have worked for Texas A&M AgriLife now for 15 years, and currently serve as a Research Specialist for the Texas Water Resources Institute. Upon completion of my PhD, it is my goal to become a research scientist for TWRI, where I can utilize remote sensing and GIS technologies to address water quality problems throughout the state of Texas. The greatest source of impairment in Texas surface water comes from nonpoint source pollution from the upland areas, and so greater understanding of land use and land cover management will be key in managing surface water bodies.

References

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