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

1. **Pre-proposal title**

Investigating total water storage, timing, and capacity for mitigating flood and drought hazards in the Texas Coastal Plain.

2. Student

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Master's of Science

Fall 2020-Spring 2022

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3. Faculty advisor:

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4. Program Being Applied For

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

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

_X__ Either program will fit my needs and eligibility

5. Previous Reception of USGS and Mills Scholarship

I have never received the Mills Scholarship nor the USGS Research Program funds before.

6. Are the funds supporting new or ongoing research?

The funds that I am applying for will be used to support new research

7. **Abstract**

With a greater incidence of floods in the Houston metropolitan area and surrounding exurban areas as a result of climate change, research is indicating that urban development is exacerbating the effects of floods. It is my intention to investigate the Texas Coastal Prairie varying in management history, vegetation composition, and soil characteristics. My research will focus on how coastal prairie could mitigate flood and droughts for the Houston Metropolitan Area due to the effects of climate change. Methods will involve profile soil moisture sensors, eddy covariance, and plant water use measurements to evaluate water storage capacity dynamics between rain events and estimated, water storage capacity through time. The objectives are to observe soil moisture and plant water use during late Spring of 2021 and on into the summer to get a data set of water usage during both wet and dry seasons. The following Fall will focus solely on data analysis and report composition. This project will help guide restoration and management of coastal prairie within the greater Houston area to protect downstream urban and suburban infrastructure from future flood risks.

8. Description of Research

a. *Statement of critical regional or state water problem.*

Climate change is beginning to grow more severe and with it, the frequency of severe floods and droughts. One of the worst floods in recent memory in this region of Texas was the flood caused by Hurricane Harvey in 2017 which caused over $100 billion in damage from a record amount of rainfall. In addition, 2011 saw the worst one-year drought that Texas has ever experienced leading to immense economic losses and killing approximately 500 million trees across the state. With a larger number of these natural hazards expected for the future, it will be important to know how to mitigate these events especially when it comes to the restoration and management of native ecosystems. If we knew the proper vegetation, soil characteristics, and management strategies to maximize the water storage capacity of native prairie, we could reduce property loss while also preserving natural environments. In addition, the water retention of native prairie could increase the resiliency of the surrounding landscape to drought reducing the chance of another, major plant die-off and the subsequent damage to wildlife habitat. It is for this reason that I would like to investigate and compare the water storage capacity of native or restored prairie to that of other ecosystem characteristics or landscape patterns. The primary entity that desires this project is the Department of Ecology and Conservation Biology at Texas A&M University.

b. ***Nature, scope and objectives of the research***

The nature of my project is meant to answer the question of whether or not the restoration of native prairie could not only serve the State of Texas by preserving the native biodiversity, but could also help provide a way to guard against extreme weather events. This project could provide information which would pave the way to helping Houston and its hinterlands save millions of dollars in economic and property losses by reducing the damage of frequent floods or severe droughts. The research will take place at an area of private property called Cook's Branch Conservancy near Montgomery, TX. The Conservancy consists of 6,000 acres of land and is being actively managed to preserve the native woodlands and grasslands that are normally found in East Texas. Here, I will examine several parcels of coastal prairie in various ecological states. These states will include prairie that recently underwent prescribed burning, prairie that is currently experiencing woody plant encroachment, and prairie that is degraded by non-native species. The soil moisture storage and water use dynamics of these prairie sites will be compared to pine forest and bottomland hardwood forest, two other common natural landscapes in the region. I will make regular biweekly trips to collect data on soil moisture changes and water consumption by the plants. That time period will also be spent maintaining any measuring equipment left in the field to record data in real-time, and in analyzing the data. In mid-September or early October 2021, the data collection will end and the primary work will mostly focus on the composition of my thesis paper.

c. ***Methods, procedures and facilities***.

My first visits to Cook's Branch will involve determining where the access tubes for collecting soil profiles are to be placed. Next, I plan to use a Giddings Rig to drill access holes at the pre-determined sites in each of the five parcels of land. Ultimately, the plan is for there to be 25 access tubes installed across the study area with five access tubes placed equidistant from each other. These access holes will be used to collect profile data on soil moisture using a Diviner 2000 unit from Sentek technologies. Equipment will be installed in March 2021 for continuous measurement throughout the entire year and includes an eddy covariance system in the restored native prairie (prairie control) and soil and vegetation sensors in the remaining sites (prairie control, transitioning prairie, degraded prairie, pine forest, and bottomland hardwood forest). The Eddy Covariance system is part of the Texas Water Observatory and includes a full suite of meteorological measurements, spectral sensors, phenology camera, and continuous measures of evapotranspiration and carbon uptake. In all, the Eddy Covariance Tower, will measure variables such as rainfall, wind speed and direction, photosynthetically active radiation (PAR), relative

humidity, CO2 mix ratio, H2O mix ratio, and temperature. Data will be uploaded nightly to the TWO database. For soil moisture sensing, I will use a combination of TDR and capacitance-based sensors installed to depths up to 1.6 meters. All sensors will be calibrated for the local soils, which are primarily sandy. Sap flow sensors will be installed in trees and saplings at all sites where trees are present. In regards to the section of prairie overrun by invasive species, the invasives that I am generally looking for include Chinese Tallow (*Triadica sebifera*) and McCartney Rose (*Rosa Bracteata*). To evaluate the water consumption of these species, I will install sap flow sensors to the Chinese tallow trees while for the McCartney Rose, since it is a shrub species, I plan to install soil moisture sensors under the plants and then compare the measurements that those sensors to other soil moisture sensors farther away from the plants. The soil moisture sensors will be placed at varying depths underneath McCartney Rose individuals in order to get a complete picture of water use by the plants. This is to see if there is a significant difference in soil moisture values between native prairie vegetation containing invasive species nearby and those that do not. Lastly, it is planned to clip some of the grassland plants within the prairie control, transitional prairie, and degraded prairie in order to observe changes in biomass as the year progresses. When analyzing the data, I plan to use Microsoft Excel to compile the information, develop graphs and other visuals, and to identify trends. I also will use the program SWAT to model the nearby Lake Creek watershed and the surrounding lakes under future conditions to see whether or not runoff will change assuming present conditions stay the same.

d. ***Statement of expected results or benefits.***

There are several results that I expect to get from this project. One of the results that I anticipate getting are that the recently burned prairie that is open to biological succession will end up losing the most water at first, but as the year goes on and native plants begin to establish, more water will be taken up and runoff will decrease noticeably. It is also believed that this research study will find that the encroaching trees and invasives are weakening the resiliency of the more mature grasslands and is therefore reducing the ability of the ecosystem to retain water and perform its functions. In other words, it will prevent the prairie from performing its normal, ecosystem services. On top of this, it is expected that the models from SWAT will show a decrease in the runoff from the prairie control if it is allowed to go through the natural process of succession. This information is expected to be used as an incentive to convert more parcels of land back into native prairie so as to protect human communities from inundation and to reduce the detrimental effects of drought. It will also aid in the estimation of open spaces, including the hydrologic services and the associated economic benefits to the region. In this way, the restoration of native ecosystems throughout the Texas Coastal Plain will have a solid, economic goal in mind.

9. **Intended Career Path**

The primary career path that I intend to pursue is to work in the government sector. Specifically, I plan on working for either the National Park Service, the U.S. Geological Survey or the U.S. Forest Service as a hydrologist monitoring water quality or as a water resource manager. However, I am also open to other potential career paths. For example. I am open to working for a local river authority, specifically the Brazos, San Antonio or Guadalupe River Authority since I am most familiar with those areas. In addition, there is the possibility that I may pursue a career as a consultant helping to restore freshwater or estuarine ecosystems. Lastly, I might pursue a career path a state government agency such as the Texas Commission of Environmental Quality or Texas Parks and Wildlife.

References:

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Other Required Information

10. **Academic qualifications of the student**

My current degree plan is to pursue a Master's of Science in Water Management and Hydrological Science with an emphasis in ecohydrology. My degree plan includes taking Ecological Restoration of Wetlands and Riparian Systems, Water Resource Planning and Management, Small Watershed Hydrology, and Seminar during the Fall of 2020. In the Spring of 2021, my schedule will involve Three Credit Hours in Research, Ecosystems Global Change, and Issues in Water Resources. The Fall of 2021 will be spent focusing on research as well as taking courses in Research Statistics and GIS. Finally, for the Spring of 2022, my last semester, I will be focusing on my Thesis defense and taking pertinent elective courses. My grades so far are; An A in Water Resources Planning and Management, A B in Small Watershed Hydrology, An A in Ecological Restoration of Wetlands and Riparian Systems, and an undetermined grade in Seminar.