Exploring Future Potential Expansion of Arid Conditions in the Texas-Mexico Transboundary Region

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Abstract

- In this study, the current and future aridity index for the transboundary states of Texas, Tamaulipas, Nuevo Leon, and Coahuila were calculated to determine how aridity levels could potentially extend in this already semiarid region.
- We hypothesize that by calculating the aridity index for our study area we will see how impacts associated with aridity (e.g., water scarcity) could affect this region in the future.
- We used ArcGIS and bioclimatic variables extended for three general circulation models (CM3, HadGEM, IPSL) at two climate change emissions scenarios (RCP 4.5, RCP 8.5), to calculate the aridity index for our study area.
- Preliminary results show that there will likely be slight but relevant changes to the distribution of arid zones in the future of our study area (e.g., 2050, 2070)

Introduction

- **Aridity** is a type of climate that has **little to no moisture or is a barren landscape.**
- **Texas** has a diverse climate that ranges from **arid to semi-arid** in the west to humid and subtropical in the east. Locally, that would make **southern Texas semi arid and subtropical.**
- **Drought** is considered a **prolonged period of below normal precipitation**; it can impact the **economy, environment, and trigger health and safety problems**.
- Our objective is to use GIS modeling to depict the potential expansion of arid conditions in our study area (Texas, Tamaulipas, Coahuila, Nuevo Leon) in the future (2050, 2070).
- Knowing the potential risks of arid land expansion and associated extreme weather events (e.g., extended drought) will help us to initiate informed strategies into coping with these climate changes at many levels.

Figure 1. Photo of a Texas State Park Officer walking over dry soil during the drought of 2011. (Source Tony Gutierrez Associated Press)

Materials and Methods

Bioclimatic variables
- Variables for the GCM's CM3, HadGEM, & IPSL were downloaded from WorldClim.
- The variables were cropped to fit the study area in ArcGIS.

Calculating Aridity Index
- Lang's aridity index (aka Lang's Rainfall factor) was calculated through the formula P/T=AI where P is annual precipitation (bio_12) and T is annual mean temperature (bio_1).

Creating Maps
- Maps were created for current aridity levels in the study area and for the future years (2050, 2070) and emission scenarios (RCP 4.5 and 8.5)

Question and Hypothesis

- **Question:** Will the transboundary states of Texas, Tamaulipas, Nuevo Leon, and Coahuila be affected by an expansion of arid conditions in the future?
- **Hypothesis:** We hypothesize that aridity will increase in the transboundary states of Texas, Tamaulipas, and Coahuila in the future.
- **Figure 2.** Map of study area which covers Texas, Tamaulipas, Nuevo Leon, and Coahuila.

Results

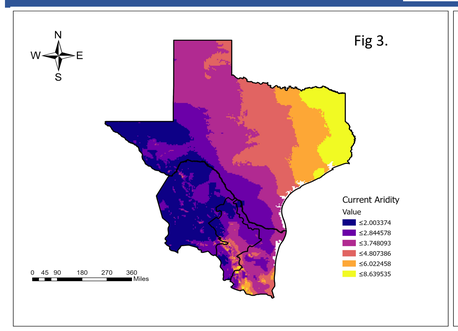

Figure 3. Current aridity in the study area. Lower values and darker colors represent higher aridity while higher values and lighter colors are lower in aridity.

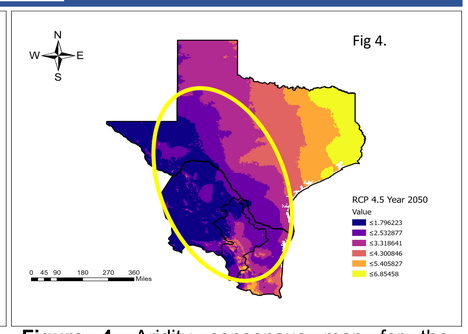

Figure 4. Aridity consensus map for the intermediate emissions scenario (RCP 4.5) for the year 2050. Aridity has increased in the northwestern portion of the study area.

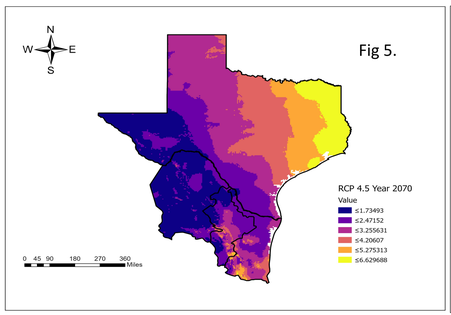

Figure 5. Aridity for the RCP 4.5 emissions scenario for the year 2070.

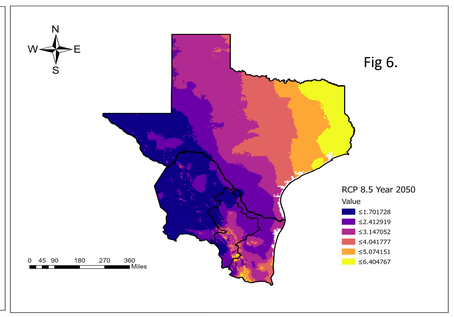

Figure 6. Aridity consensus map for the RCP 8.5 scenario for the year 2050.

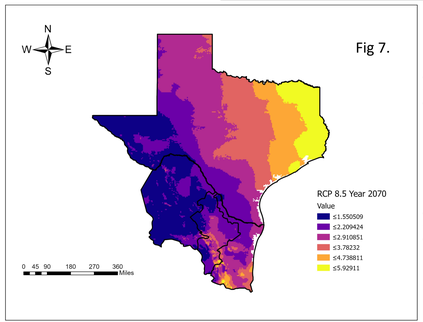

Figure 7. Aridity consensus map for the RCP 8.5 scenario for the year 2070. Aridity expansion over current levels is greatest in this scenario.

Conclusion/Discussion

- Aridity is predicted to increase in the years of 2050 and 2070 based on the intermediate (RCP 4.5) and high emissions scenario (RCP 8.5). These results support our hypothesis.
- For all scenarios, aridity is predicted to increase primarily in the western portion of the study area (e.g., SW Texas and Coahuila states; **Fig 4** yellow circle).
- Some aridity changes are also predicted in northern and southern Texas as well as in Tamaulipas.
- The most pronounced aridity expansion is seen in the highest emissions scenario (RCP 8.5) for 2070 (**Fig 7**).
- Given the outsized role that water (e.g., soil moisture) has on agriculture and ecosystem management (e.g., biodiversity conservation) in the study area, these results can help guide adaptive decision-making within this regional context.

Future Work

- Ongoing work is focused on replicating this study using other aridity index formulas such as De Martonne's aridity index.
- Additionally, we would like to assess how other proposed climate change impacts (e.g., extreme precipitation events) could interact with ongoing processes (e.g., heat islands, urbanization) in our study area's future

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