Water Quality Assessment in Relation to Land Cover Change within the La Nana Bayou Watershed in East Texas
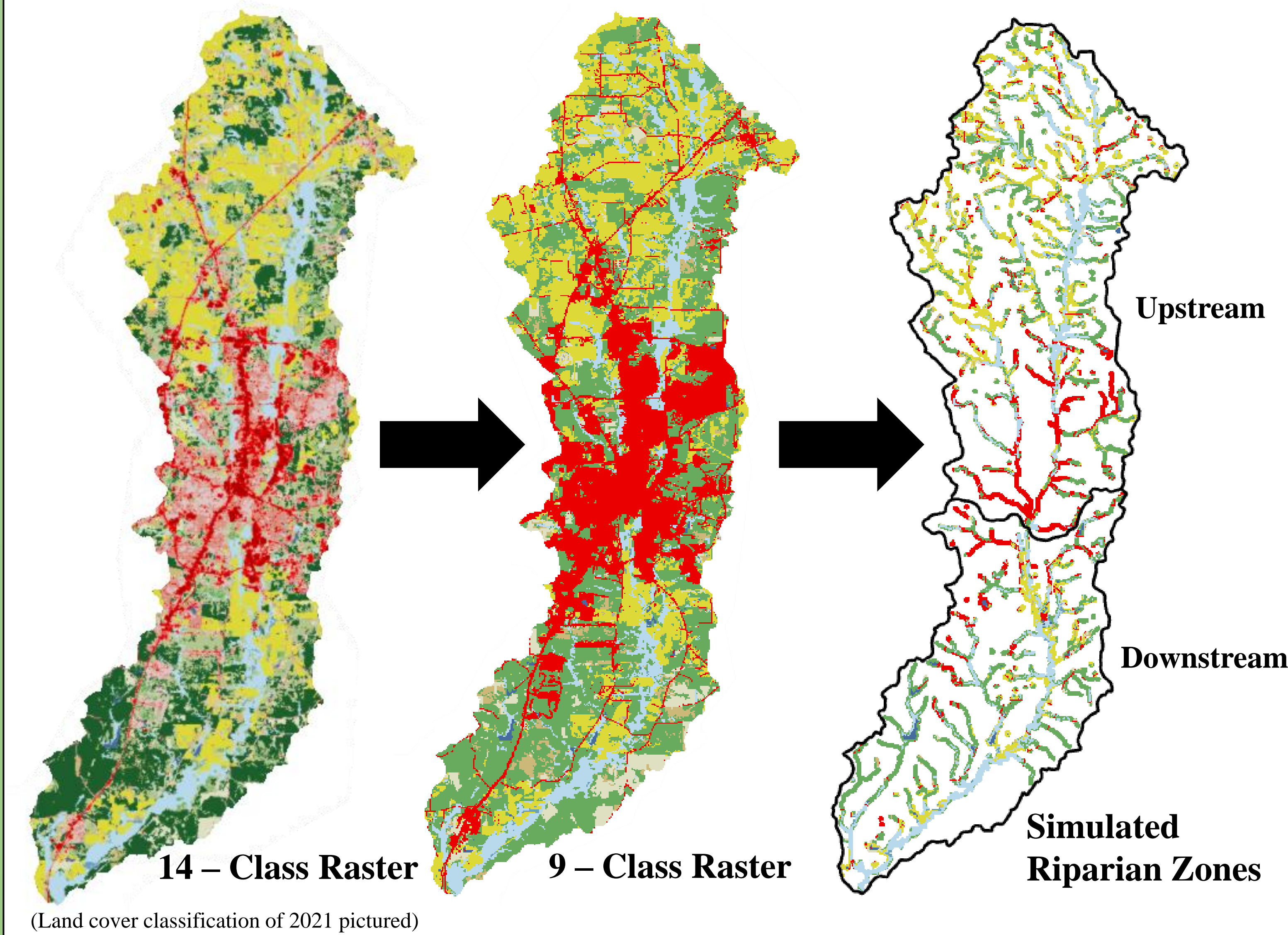
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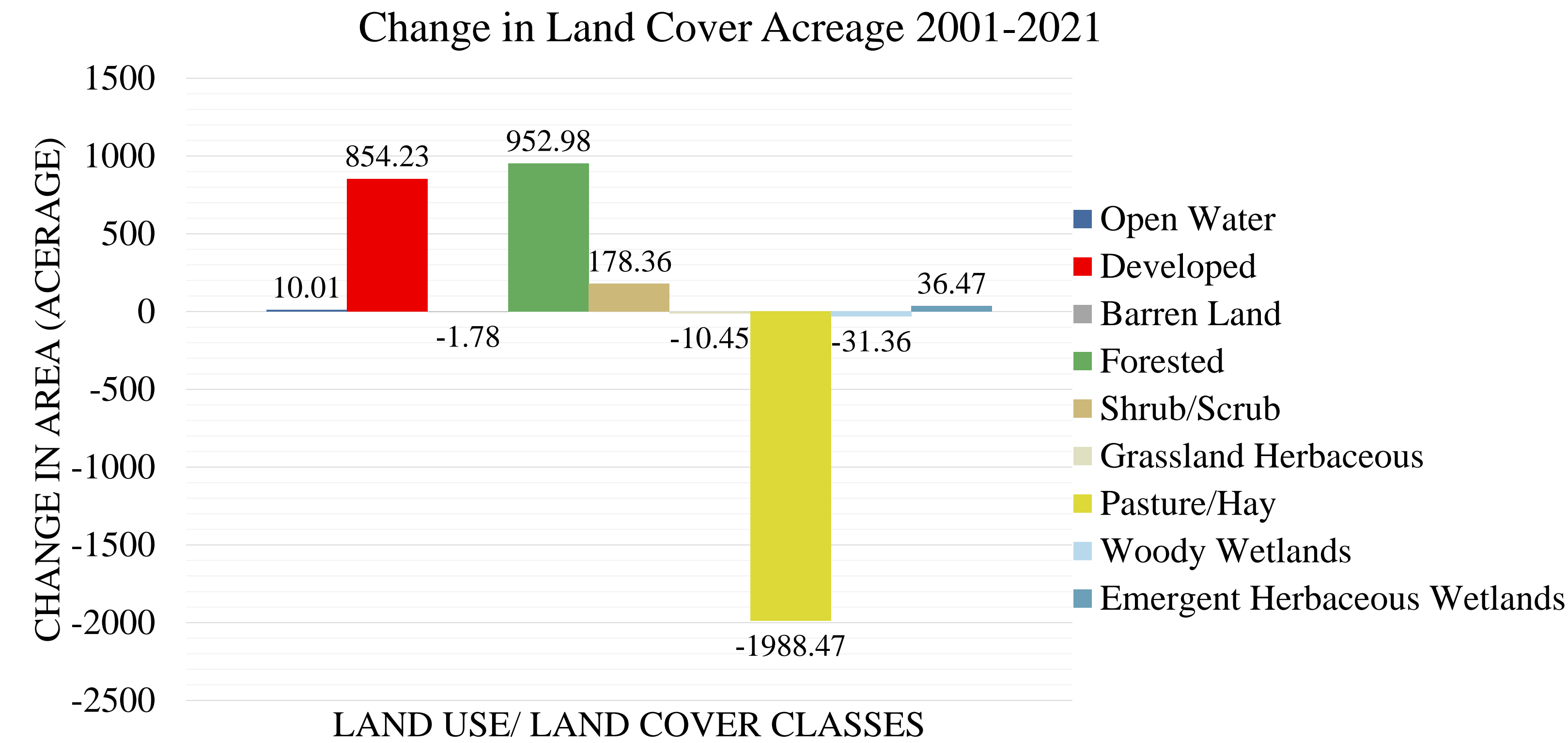
INTRODUCTION

This research uses land cover mapping over time to assess water quality in a watershed in relation to socioeconomic development. With the La Nana Bayou Watershed positioned in the heart of an urbanized environment; it is subject to negative human induced alterations that affect the natural functionality of its system. When water quality indicators are successfully related to land cover maps, changes within the landscape that impact a watershed's health can be monitored routinely. Over a 20-year span (2001-2021) within the study area, the following land cover types were used as water quality indicator, including the riparian zone, impervious cover, and forest cover. The assessment of water quality based on land cover maps was validated for accuracy using field measured water quality parameters and census data. This study's purpose is to demonstrate the feasibility of using land cover mapping to obtain water quality indicators of a river basin and provide feedback on whether it is more efficient when compared to traditional field-based water quality testing.
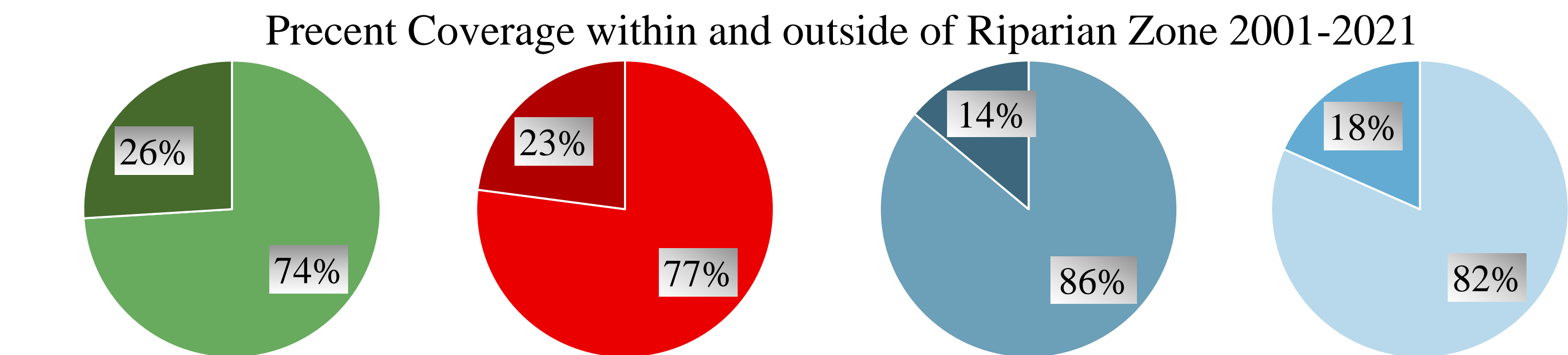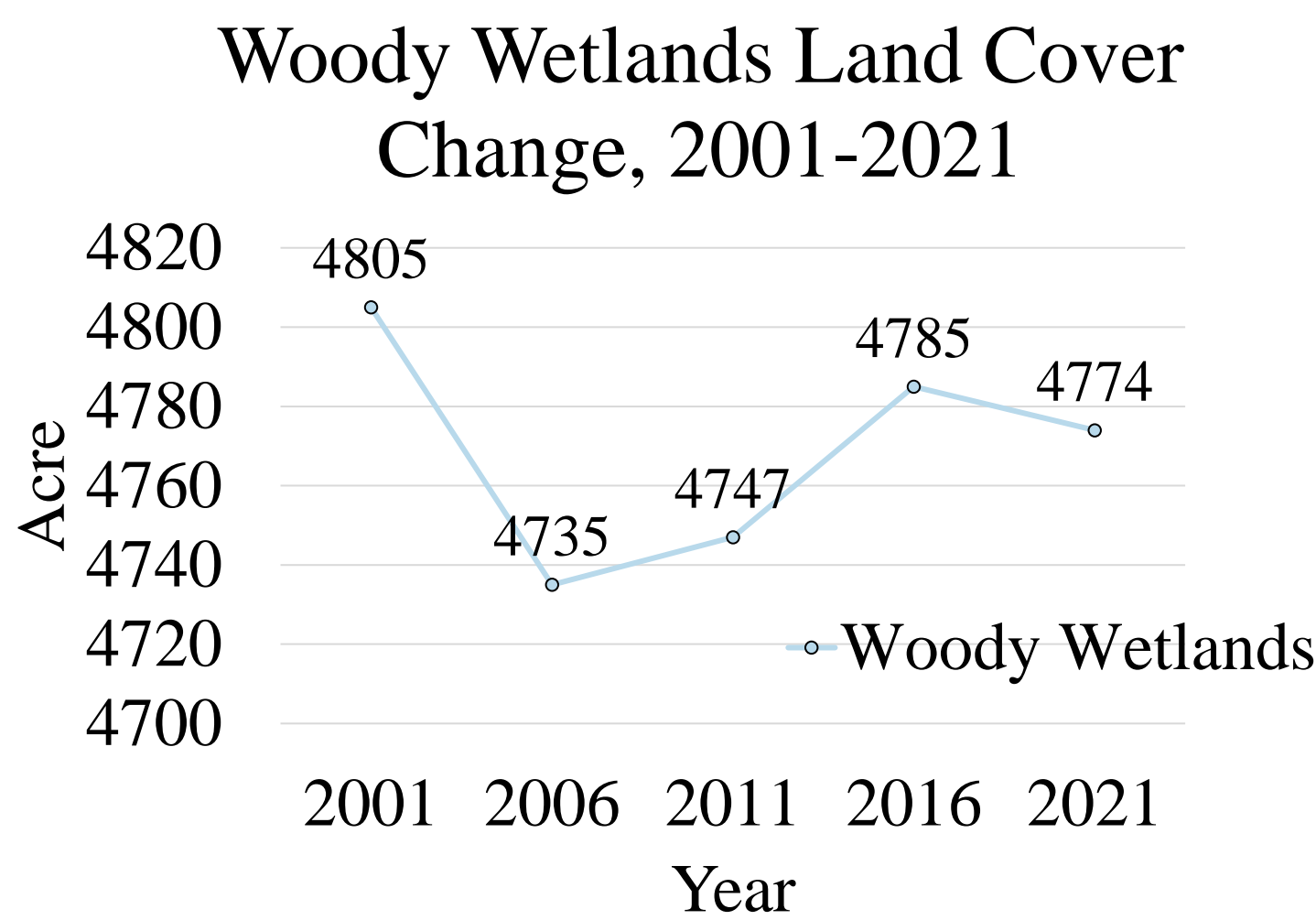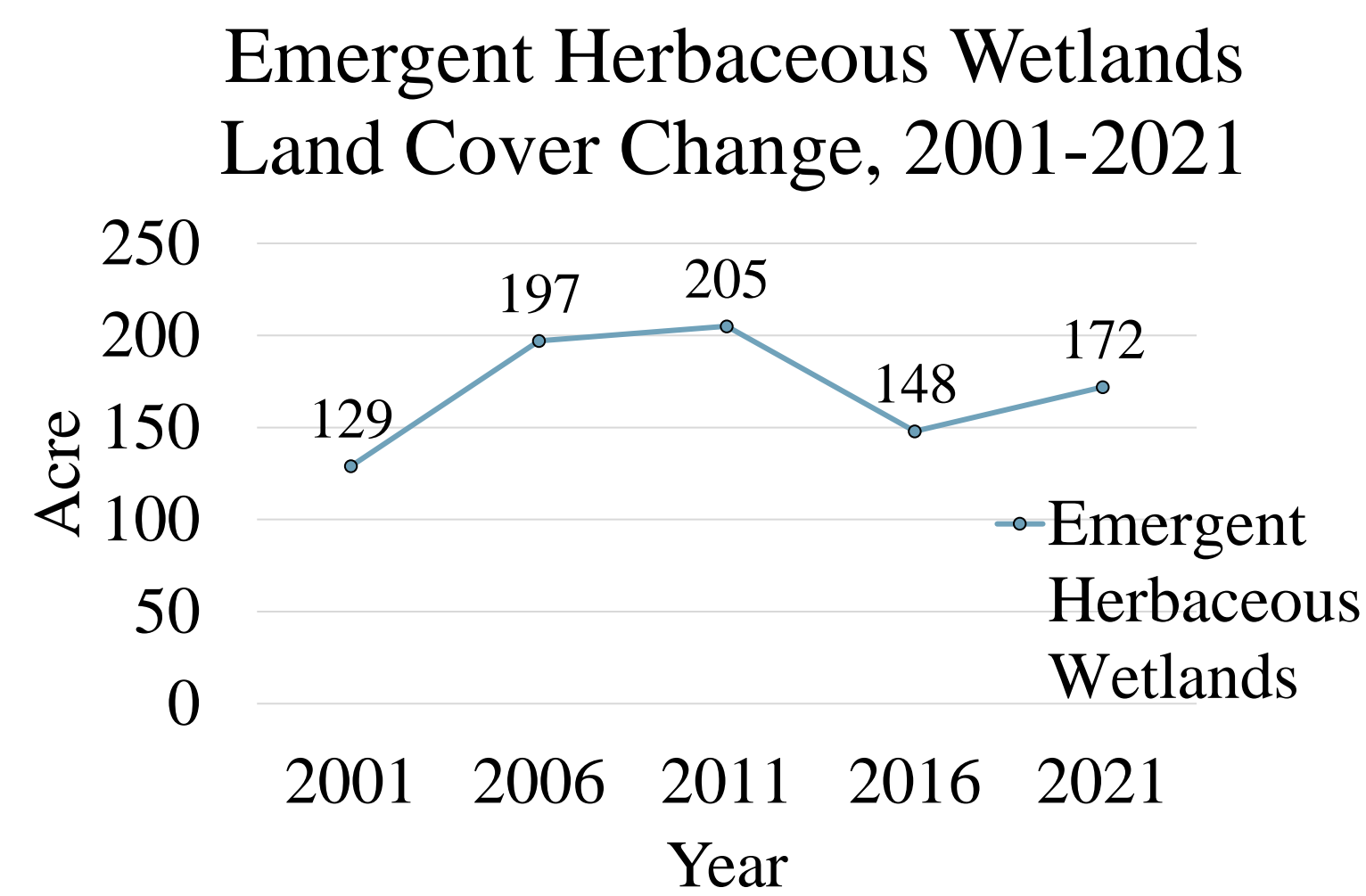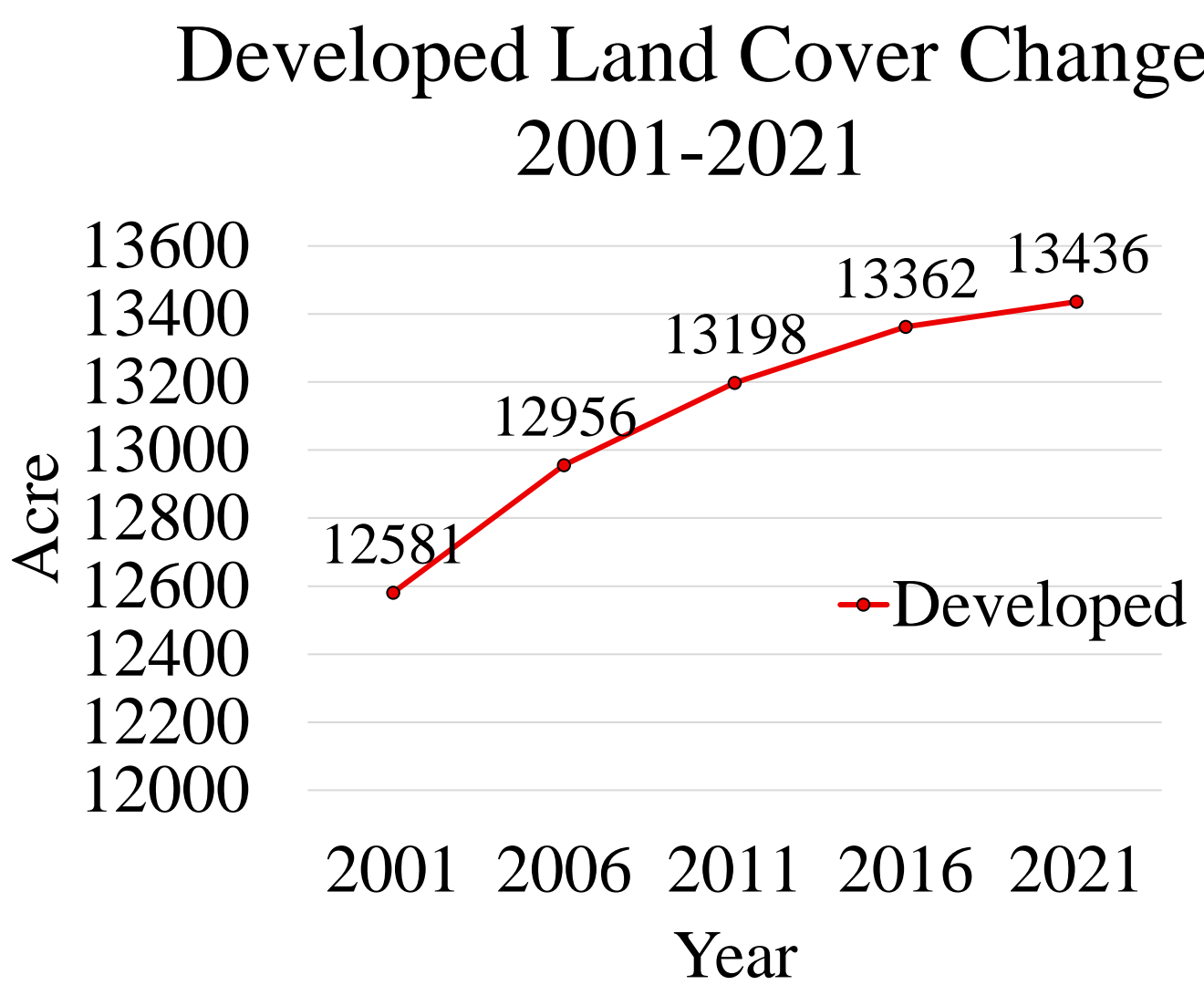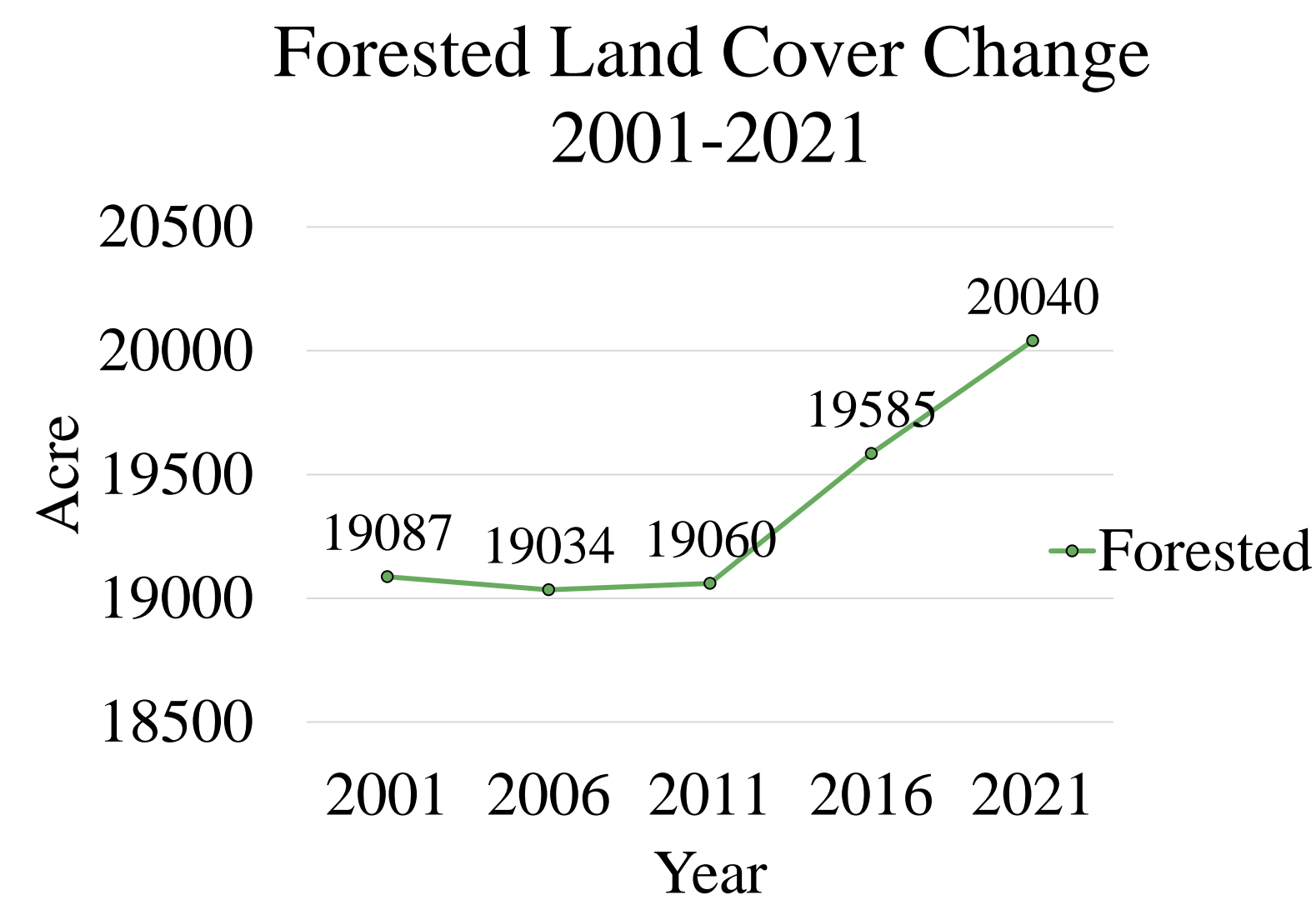
METHODS

- Landcover maps of the La Nana Bayou Watershed's Boundary were acquired from the National Land Cover Database (NLCD). Five total maps were used to analyze the watershed over a 20- year study period, representing the watershed at year 2001, 2006, 2011, 2016, and 2021.
- The land cover maps were reclassified from 14 classes to 9 classes, where the 4 development classes were combined into the "developed" class and the 3 forested classes into the "forested" class.

- Land cover analysis was done to identify potential water quality indicators within and outside of the simulated 200-ft riparian zones, focusing on the areas of impervious and forested covers in five-year increments (2001-2021) using the 9-class landcover maps.
- Finally, the water quality indicators were validated by examining in situ water quality monitoring parameters (pH, DO, TSS, Temperature, and *E.coli*) and the census data (livestock and human populations).

14 – Class Raster **9 – Class Raster** **Simulated Riparian Zones**

Upstream

Downstream

(Land cover classification of 2021 pictured)

RESULTS

Change in Land Cover Acreage 2001-2021

CHANGE IN AREA (ACERAGE) vs LAND USE/ LAND COVER CLASSES

Open Water 10.01
Developed 854.23
Barren Land -1.78
Forested 952.98
Shrub/Scrub 178.36
Grassland Herbaceous -10.45
Pasture/Hay -1988.47
Woody Wetlands -31.36
Emergent Herbaceous Wetlands 36.47

Note: The land cover classes that experienced the most drastic change in acreage included Pasture/Hay with a decrease of 1988.47 acres, Developed with an increase in 854.23 acres and Forested with and increase of 953.98 acres.

Forested Land Cover Change 2001-2021

Forested: 2001: 19087, 2006: 19034, 2011: 19060, 2016: 19585, 2021: 20040

Developed Land Cover Change 2001-2021

Developed: 2001: 12581, 2006: 12956, 2011: 13198, 2016: 13362, 2021: 13436

Emergent Herbaceous Wetlands Land Cover Change, 2001-2021

Emergent Herbaceous Wetlands: 2001: 129, 2006: 197, 2011: 205, 2016: 148, 2021: 172

Woody Wetlands Land Cover Change, 2001-2021

Woody Wetlands: 2001: 4805, 2006: 4735, 2011: 4747, 2016: 4785, 2021: 4774

Precent Coverage within and outside of Riparian Zone 2001-2021

Forested: 26% / 74% Developed: 23% / 77% Emergent Herbaceous Wetland: 14% / 86% Woody Wetland: 18% / 82%

Note: The top 4 land cover classes that would have the most damage to the watershed's natural functions were identified and monitored closely. The Forested land cover class had a small decrease from 2001-2006, but then increased from 2006-2021 significantly. The Developed land cover class increased steadily from 2001-2021. When looking at the proportion of change that occurred within and outside of the riparian zones, 26% Forested, 23% Developed, 14% Emergent Herbaceous Wetland, and 18% Woody Wetland land cover change occurred within the simulated riparian zones.

DISSCUSION

Land Cover Analysis:

- The land cover analysis results showed that there was an increase of the Forested cover type area. This could positively affect the functionality of the La Nana Bayou Watershed by adding to the canopy cover, reducing stream side erosion, and increasing the ecosystems wildlife diversity.
- The land cover analysis also showed an increase of the Developed cover type area. This could negatively effect the watershed natural functionality by decreasing riparian zone coverage, increasing pollutant discharge, and increasing impervious cover.
- The increase in Forested and Developed areas came primarily from the conversion of land use from the Pasture/Hay areas.

Water Quality Validation:

- The water quality validation showed that there was an increase in livestock and human population over the 20-year time frame.
- This could be seen through the increase in livestock (mostly poultry) populations in and around the riparian zones that would increase pollutant inputs in the watershed.
- Also, the increase in human population within the watershed's boundary from 2001-2021 could contribute to the pollutant sources.
- Water quality parameters attained from monitoring stations would be used for validation.

CONCLUSION

The health of a watershed can be determined using spatial analysis techniques. Throughout the 20-year time span studied, the La Nana Bayou Watershed had many water quality indicators that could be monitored over time using land cover change analysis. The analysis within and outside of the simulated riparian zones was used to confirm that the watershed underwent positive and negative changes that could disrupt the natural functionality of its system.

Acknowledgements and Data Sources