Rowan University
Remote Sensing of the Environment
Final Project May 2022

Landscape Analysis San Antonio, Texas: 1991 and 2021

Gina DiMaio
B.A., Biological Science / GIS Minor
Expected: December 2022

INTRODUCTION

The study area presented here includes the city of San Antonio, located in Bexar County, within south-central Texas. The geographic coordinates for The Alamo in downtown San Antonio are provided for reference: 29°25'32.6"N 98°29'10.6"W. This imagery occupies two ecoregions: Edwards Plateau in the north, also called "hill country" consisting of rocky hills, freshwater springs, caves, and juniper-oak woodlands. The soil here is thin with limestone bedrock. The Texas Blackland prairies lie to the south with fertile clay-based soils known for tallgrass prairies - many of which have been converted to agriculture.

Based on US Census data, the population of San Antonio in 1990 was 997,434 and increased to 1,547,253 in 2020. The city was promoted to the second largest in Texas and the 7th fastest-growing US city overall after experiencing a 15.9% population increased from 2000 to 2010. The dramatic change in population has no doubt resulted in landcover changes to urban/suburban and vegetated areas that can be observed with remote sensing technology.

The goal of this project was to analyze Landsat satellite imagery from 1991 and 2021, using TerrSet2020 software, to answer the following questions about land cover in the city of San Antonio:

(i) How much developed (urban and suburban) landcover is there? Where is it and how has it changed?
(ii) How much agriculture landcover is there? Where is it and how has it changed?
(iii) What is the temperature across landcover types?

METHODS

Data preparation began by using USGS Earth Explorer to locate the desired landsat scenes; data source information was provided to Dr. Christman for initial processing. Once processed, the WINDOW tool was used to crop the imagery. Starting with the 2021 imagery a true color image was made via the COMPOSITE tool using Bands 2, 3, 4. 2021 NDVI was created via the Image Calculator with the formula: (b5-b4)/(b5+b4). 2021 False IR was created using Bands 3,4,5. For the 1991 data, a true color composite was made with Bands 1, 2, 3. 1991 NDVI was created via: (b4-b3)/(b4+b3). 1991 False IR was created using Bands 2,3,4.

Different land cover types for the study area were identified in both 1991 and 2021 imagery; these features were digitized. MAKESIG and MAXLIKE tools were used to produce the 1991 9-class map and 2021 8-class map. AREA tool was used on both maps to measure total square miles for each class.

Measuring urban/developed landcover
Using the information from the AREA tool the difference in urban and suburban landcover from 1991 and 2021 was calculated. Land Change Modeler was utilized to map gains/losses in both suburban and urban landcover.

Measuring agriculture landcover
Using the information from the AREA tool the difference in agriculture landcover from 1991 and 2021 was calculated. TerrSet2020 Land Change Modeler was utilized to map gains/losses in agriculture.

Temperature across landcover types
A line was digitized using 1991 imagery, PROFILE tool was used to sample the temperatures on Landsat Band 10 (2021) and Landsat Band 6 (1991), IPF files were manipulated in MS Excel to produce graphs comparing the temperature and distance over miles.

RESULTS

Figure 1. 1991 True Color

Figure 2. 2021 True Color

Figure 3. 1991 False IR

Figure 4. 2021 False IR

Figure 5. 1991 NDVI

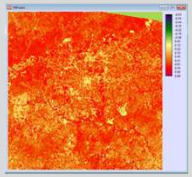


Figure 6. 2021 NDVI

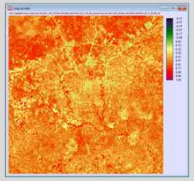


Figure 7. 1991 9-class

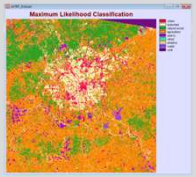


Figure 8. 2021 8-class

Figure 9 . 1991 Land Cover Area

Category	Square miles	Legend
1	141.413140	urban
2	304.672282	suburban
3	463.892548	natural scrub
4	1169.195781	agriculture
5	88.605780	quarry
6	3.620498	cloud
7	4.691115	shadow
8	6.302774	water
9	25.874453	void

Figure 10. 2021 Land Cover Area

Category	Square miles	Legend
1	158.656289	urban
2	280.564816	suburban
3	446.010365	natural scrub
4	1079.380388	agriculture
5	127.598328	quarry
6	33.131782	cloud
7	81.248722	shadow
8	1.677682	water

Figure 11. Change between 1991-2021

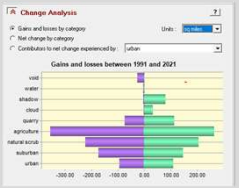


Figure 12. 1991 Gains/losses agriculture

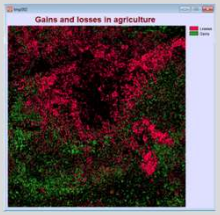


Figure 13. Gains/losses suburban

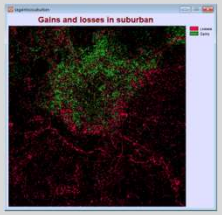


Figure 14 . 1991 Gains/losses urban

Figure 15. 1991 Temperature Profile

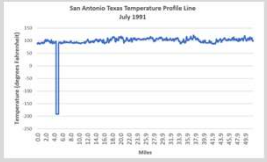
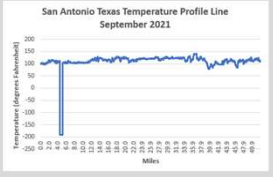


Figure 16. 2021 Temperature Profile



Special thanks to Dr. Zach Christman for his support and guidance throughout this project.

DISCUSSION

According to this analysis, 1991 imagery had a total of 446 sq. miles of developed (urban + suburban) landcover and 1169 sq. miles of agriculture landcover (Figure 9). The 2021 imagery resulted in 439 square miles developed and 1079 sq. miles agriculture (Figure 10). Between this 30-year span, according to this analysis urban landcover increased by ~17 sq. miles and agriculture decreased by ~89 sq. miles. Surprisingly, suburban landcover area decreased by ~24 sq. miles.

However, looking at the Landsat scenes it is obvious these two extents are not quite the same with a small corner of the 1991 imagery being cut off. Combine this with noticeable clouds/shadows in the 2021 imagery these may have resulted in discrepancies that may have skewed the data. It is also worth noting the 1991 imagery was acquired in July and 2021 imagery was acquired in September and with different Landsat technology which is more accurate in 2021 than in 1991.

Despite the total area calculations, observing the true color images (Figures 1 and 2) and the classified landcover maps (Figures 7 and 8) appear to show a considerable increase in developed landcover – especially suburban. Figure 13, shows gains in suburban landcover concentrated in a central area – this is mainly around and within TX State Hwy Loop 1604 which encircles the city of San Antonio. Comparatively, gains in urban landcover (Figure 14) appear more thinly spread out within and outside the city. Most agriculture landcover according to Figure 7 and 8 lies south of the natural scrub area most likely due to the location of two different ecoregions and how fertile the land is there. This is also seen in Figure 3 and 4 with the differences in the locations and intensity of the bright red and dark red areas. It's also likely, the agriculture landcover is over-represented and confused with various types of vegetation ranging from woodlands, grassland, lawn, golf courses, and comparing these to different agriculture crops.

Looking at the temperature profiles (Figures 15 and 16) it appears the September 2021 imagery has higher temperature values in some area compared to the July 1991 imagery – especially between miles 12 to 38. The beginning of the line started in a forested area northwest of the city which shows lower values compared to the middle of the line as it cross into the heart of the city which would have more development impervious cover. There is a dramatic dip in temperature on both graph around mile 4 – possibly skewed by a feature on the landscape such as water or something else.

Due to some of the inconsistencies in land cover class areas, and the extent of the landsat scenes, to get an accurate picture of landscape change across the San Antonio region, further analysis of multiple scenes should be done from different times of the year - not just relying on two scenes. Landcover types could also be further broken down especially regarding vegetation. Other questions worth investigating include how the amount of water in the landscape has changed as this is certainly impacted by increased population and climate change.

DATA SOURCES & REFERENCES

USGS Earth Explorer. https://earthexplorer.usgs.gov/

ID: LT05_L2SP_027040_19910718_20200915_02_T1
Date Acquired: 1991/07/18
Path: 027 **Row:** 040

ID: LC08_L2SP_027040_20210906_20210915_02_T1
Date Acquired: 2021/09/06
Path: 027 **Row:** 040

Department of Planning and Community Development. (2012). *San Antonio Demographic Distribution and Change 200 to 2010 Summary Report.* https://www.sanantonio.gov/portals/0/Files/planning/Census2000To2010DemographicChangeSummaryReport.pdf

San Antonio River Authority. (no date). *Ecoregions of the San Antonio river watershed.* https://www.sariverauthority.org/be-river-proud/ecosystems/ecosystems-san-antonio-river-watershed

San Antonio, Texas Population History 1880 - 2019. https://www.biggestuscities.com/city/san-antonio-texas