Vegetation Change Over 20 Years in the Coachella Valley of Southern California

## Author: Whitney Newcomb

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# Introduction

The Coachella Valley area, especially the city of Palm Springs, (Figure 1) is known for its lush greenery and expansive golf courses. It’s very easy to forget that you’re in the middle of a desert (with only an average of 5.5 inches of rain each year) and since World War II the area has become quite popular (Deluca and Schiecter, 2015). In the 2010 California Department of Water Resources Urban Management Plan, Palm Springs had the highest usage of water in the state with over 700 gallons of water being used per person per day (this did not include agricultural water). With the recent drought California has been in areas like the Coachella valley may need to reevaluate their water usage.

This report will look into land cover change from March 27th 1984 to March 22nd 2014 and specifically calculates the Normalized Difference Vegetation Index (NDVI) for the cities of Palm Springs, Palm Desert, Rancho Mirage, Indio, Cathedral City, and Coachella and the potential increase in the amount of acres of very healthy vegetation.



Figure 1: Locator Map - Coachella Valley Southern California

# Methods

The data for this lab was found through the USGS Earth Explorer website. The image from March 27th 1984 was found in the Landsat 1-3 Multispectral Scanner sensor archive. The image from March 22nd 2014 was found in the Landsat 8 Operational Land Imager/ Thermal Infrared Sensor archive. A vector shapefile of the boundaries of all southern Californian cities was found at the Southern California Association of Governments website. Both data sets are displayed in Near-Infrared (NIR) false color composites with the NIR band displayed in red, the red band displayed in green, and the green band displayed in blue. The data was then taken into ENVI and a Region of Interest (ROI) was created around the geographic extent which can be seen in Figure 2 and Figure 3. The 1984 and 2014 rasters were both subset with the ROI.

Next the data was radiometrically calibrated for top of atmosphere reflectance. ENVI’s Radiometric Calibration tool was used for this process on both data sets.

The NDVI was then calculated for both images using ENVI’s NDVI tool. An accuracy assessment was then completed for the 2014 NDVI values using 30 random points generated by ArcMap and compared with Imagery from Google Earth (Figure 5). No accuracy assessment was done for the 1984 data set due to the lack of high spatial resolution reference data.

The datasets were then taken into ArcMap and the NDVI raster was cropped within the Cities Boundary. The NDVI values were set into three vegetation categories: values over 0.10 (these values show mostly mixed pixels in urban areas, values over 0.25 (showing healthy vegetation), and values over 0.50 (showing very healthy vegetation). These areas with corresponding NDVI values were found with ArcMap’s Raster Calculator for both data sets. The vast majority of the vegetation within the cities was not agricultural land.

The area in acres of NDVI values greater than 0.10 (0.25 and 0,50) was then calculated for both data sets to determine the amount of vegetation change in the Coachella Valley area in a span of 20 years.

# Results

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Figure 2: Coachella Valley cities showing locations of vegetation and corresponding NDVI values for March 22nd, 2014 on a NIR false-color composite.



Figure 3: Coachella Valley cities showing locations of vegetation and corresponding NDVI values for March 27th, 1984 on a NIR false-color composite.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **NDVI values** | **1948 Acres of Vegetation** | **2014 Acres of Vegetation** | **Increased by** | **Percent Change** |
| **> 0.10** | 188.34 | 834.40 | 646.06 acres | 343.03 % |
| **> 0.25** | 98.40 | 550.12 | 451.72 acres | 459.07 % |
| **> 0.50** | 15.02 | 265.30 | 250.28 acres | 1666.31 % |

*Table 1: Acres of Vegetation change from 1984 to 2014.*

As seen in Table 1, Figure 2, and Figure 3 the changes in vegetation, especially in that of very healthy vegetation has increased by astronomical amounts – 1666.07%; in 1984 there were only 15.02 acres of very healthy vegetation and in 2014 there were 265.30 acres. A visual inspection shows that most of this growth in vegetation did not actually occur in Palm Springs but in the neighboring cities.

The Accuracy Assessment done for the NDVI values in 2014 is shown below Table 2. Figure 4 shows the location of the 30 randomly generated points. Three land cover types were identified: urban, vegetation, and bare ground (which encompassed all desert landscapes).



Figure 4: 30 random points selected for NDVI Accuracy Assessment

|  |  |  |  |
| --- | --- | --- | --- |
| **Site #** | **Land Cover Type** | **NDVI Value** | **Description** |
| 1 | Urban | -0.079061 | Drive Way |
| 2 | Vegetation | 0.556124 | Golf course |
| 3 | Bare Ground | -0.124971 | Desert |
| 4 | Vegetation | 0.225147 | Lawn |
| 5 | Urban | -0.041716 | Road |
| 6 | Urban | -0.079572 | Roof |
| 7 | Urban | -0.001624 | Roof |
| 8 | Vegetation | -0.077929 | Mountain shrubs |
| 9 | Bare ground | -0.159386 | Mountain/deserts |
| 10 | Bare ground | -0.179088 | Desert |
| 11 | Bare ground | 0.073249 | Desert |
| 12 | Vegetation | 0.024117 | Lawn |
| 13 | Bare ground | -0.162016 | Desert |
| 14 | Bare ground | -0.164644 | Desert |
| 15 | Bare ground | -0.090131 | Unknown (possibly old agriculture land) |
| 16 | Urban | -0.084133 | Roof-top |
| 17 | Bare ground | -0.168366 | Desert |
| 18 | Vegetation | -0.112615 | Mountain Shrubs |
| 19 | Bare ground | -0.177899 | Unknown |
| 20 | Vegetation | -0.119551 | Mountain shrubs |
| 21 | Vegetation | -0.413242 | Unknown (agriculture) |
| 22 | Vegetation | 0.659169 | Golf lawn |
| 23 | Vegetation | 0.175997 | Tree (species unknown) |
| 24 | Urban | -0.179194 | Parking lot |
| 25 | Bare ground | -0.158419 | Old agriculture |
| 26 | Bare ground | -0.175765 | Desert |
| 27 | Vegetation | -0.116102 | Mountain Shrubs |
| 28 | Bare ground | -0.087906 | Sand |
| 29 | Bare ground | -0.088378 | Desert |
| 30 | Bare ground | -0.172322 | Mountains/desert |

*Table 2: Accuracy Assessment for NDVI values for 2014 data.*

# Discussion and Conclusion

The results of this project met and exceeded expectations. The Coachella Valley cities have grown immensely since the 80’s and healthy land cover has seen a rise alongside it. It’s no wonder why water usage in the area is unprecedentedly high. Further studies should be done to understand how much water is used to maintain such a large expanse of greenery amidst such an arid climate and ways to mitigate such high water usage.

The analysis could be improved with higher spatial resolution, NAIP data would be applicable and Unmanned Aerial Systems would be applicable for studies within smaller areas. The Accuracy Assessment would provide better results if field work was done instead of using Google Earth or with higher spatial resolution data. Further studies might be done on each city specifically instead of the cities bunched together.

# References

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