Land Cover, Land Use of two bioluminescent bays in Puerto Rico

Undergraduate Research
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Outline

- Introduction
- Objectives
- Study Area
- Methodology
- Result
- Discussion
- Conclusion
Introduction

- Land around Puerto Mosquito Bay in Vieques and La Parguera Bioluminescence Bay in Lajas, Puerto Rico are used to produce Land Use/ Land Cover maps.

- Land use is defined as the use of land by humans.

- Land cover is designates only the vegetation (natural or man made).
Examples: urban structures, forest, agriculture, water resources, vegetations index and others.

The Land Use/Land Cover maps have the capacity to illustrate the interaction between human and the surroundings.

In Puerto Rico, general maps of Land Uses/Land Cover were produced in 1999 for La Parguera and Vieques Island.
Land Use/ Land Cover Maps, 1999

Parguera

Vieques

Legend

Linda Velez, 1999
The Bioluminescence is the emission of light by living organism (*Pyrodinium bahamense*).

Conditions aiding the accumulation of these organisms are: shallow basin with low tidal and narrow mouth, surrounded by mangroves.

La Parguera Bioluminescent Bay has shown a decrease in its bioluminescence by approximately 80% during recent recent years compared with Puerto Mosquito Bay.
Objectives

- The main objective of this research was to produce and compare Land Use and Land Cover, specific maps for the two bioluminescence bays; using Remote Sensing and GIS tools.
Study Area

Adapted from Walker, 1997
IKONOS 1m
La Parguera Bioluminescence Bay

• The geomorphology of the area is the result of deformation of Limestone in early Cretaceous (Glynn, 1973).

• The bottom sediments are composed by fine mud, marine plants and mangrove leaves.

Scale 1,2000 (Volckmann, 1984)
The geology of Vieques consists in intrusive rocks with carbonate sediments, the bottom sediments are composed by clay.

- QTu – Sedimentary deposits undivided Marine limestone.
Methodology

- Environment for Visualizing Images (ENVI)
- Geographic Information System (GIS)
- IKONOS sensor provides spatial resolution at 1 meter and in multispectral mode, it provides imagery at 4 m spatial in four spectral bands.
- The images was displayed using all available bands; red, green, blue (RGB) and infrared band (IR).
# USGS Land-Use and Land Cover Classification

<table>
<thead>
<tr>
<th>Level I</th>
<th>Level II</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Urban or built-up land</td>
<td>11 Residential</td>
</tr>
<tr>
<td></td>
<td>12 Commercial and services</td>
</tr>
<tr>
<td></td>
<td>13 Industrial</td>
</tr>
<tr>
<td></td>
<td>14 Transportation, communications, and utilities</td>
</tr>
<tr>
<td></td>
<td>15 Industrial and commercial complexes</td>
</tr>
<tr>
<td>2 Agricultural land</td>
<td>16 Mixed urban or built-up land</td>
</tr>
<tr>
<td></td>
<td>17 Other urban or built-up land</td>
</tr>
<tr>
<td>3 Rangeland</td>
<td>21 Croplands and pasture</td>
</tr>
<tr>
<td></td>
<td>22 Orchards, groves, vineyards, nurseries, and ornamental horticultural areas</td>
</tr>
<tr>
<td></td>
<td>23 Confined feeding operations</td>
</tr>
<tr>
<td>4 Forest land</td>
<td>24 Other agricultural land</td>
</tr>
<tr>
<td></td>
<td>31 Herbaceous rangeland</td>
</tr>
<tr>
<td></td>
<td>32 Shrub and brush rangeland</td>
</tr>
<tr>
<td></td>
<td>33 Mixed rangeland</td>
</tr>
<tr>
<td></td>
<td>41 Deciduous forest land</td>
</tr>
<tr>
<td></td>
<td>42 Evergreen forest land</td>
</tr>
<tr>
<td></td>
<td>43 Mixed forest land</td>
</tr>
</tbody>
</table>

(Campbell, 2002)
## USGS Land-Use and Land Cover Classification

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>Water</td>
</tr>
<tr>
<td>51</td>
<td>Streams and canals</td>
</tr>
<tr>
<td>52</td>
<td>Lakes</td>
</tr>
<tr>
<td>53</td>
<td>Reservoirs</td>
</tr>
<tr>
<td>54</td>
<td>Bays and estuaries</td>
</tr>
<tr>
<td>6</td>
<td>Wetland</td>
</tr>
<tr>
<td>55</td>
<td>Forested wetland</td>
</tr>
<tr>
<td>62</td>
<td>Nonforested wetland</td>
</tr>
<tr>
<td>7</td>
<td>Barren land</td>
</tr>
<tr>
<td>71</td>
<td>Dry salt flats</td>
</tr>
<tr>
<td>72</td>
<td>Beaches</td>
</tr>
<tr>
<td>73</td>
<td>Sandy areas other than beaches</td>
</tr>
<tr>
<td>74</td>
<td>Bare exposed rock</td>
</tr>
<tr>
<td>75</td>
<td>Strip mines, quarries, and gravel pits</td>
</tr>
<tr>
<td>76</td>
<td>Transitional areas</td>
</tr>
<tr>
<td>77</td>
<td>Mixed barren land</td>
</tr>
<tr>
<td>8</td>
<td>Tundra</td>
</tr>
<tr>
<td>81</td>
<td>Shrub and brush tundra</td>
</tr>
<tr>
<td>82</td>
<td>Herbaceous tundra</td>
</tr>
<tr>
<td>83</td>
<td>Bare ground tundra</td>
</tr>
<tr>
<td>84</td>
<td>Wet tundra</td>
</tr>
<tr>
<td>85</td>
<td>Mixed tundra</td>
</tr>
<tr>
<td>9</td>
<td>Perennial snow or ice</td>
</tr>
<tr>
<td>91</td>
<td>Perennial snowfields</td>
</tr>
<tr>
<td>92</td>
<td>Glaciers</td>
</tr>
</tbody>
</table>

*Note. From Anderson et al. (1976, p. 8).*

(Campbell, 2002)
- **Supervised classification**
  - Parallelepiped
  - Minimum Distance
  - Mahalanobis Distance
  - Maximum Likelihood

- **Confusion Matrix method**
  - using ground truth image and ROI’s.

- **Hydrology information**, USGS publication files

![Image of a map with a green area highlighted]
Regions of Interest (ROI’s)

- The process of using known pixels identity to classify unknown pixel identity.
Index of Vegetation (NDVI)

\[ \text{NDVI} = \frac{\text{Infrared (IR)} - \text{Red (R)}}{\text{Infrared (IR)} + \text{Red (R)}} \]
Results

Legend

- Urban or built-up land
- Water
- Barren land
- Forest land
- Wetland
Maximum Likelihood

Assumes that the statistics for each class in each band are normally distributed and calculates the probability that a given pixel belongs to a specific class.

(Campbell, 2002)
Minimum Distance

Uses the mean vectors of each ROI's and calculates the Euclidean distance from each unknown pixel to the mean vector for each class.

(Campbell, 2002)
Parallelepiped classification

Ranges of values within training data to define regions within a multidimensional data space.

(Campbell, 2002)
Mahalanobis Distance classification is a direction sensitive distance classifier that uses statistics for each class.
Minimum Distance
Mahalanobis Distance
Maximum Likelihood
Distribution of Classes

La Parguera Bioluminescence Bay
- 55% (Green)
- 12% (Blue)
- 9% (Yellow)
- 1% (Red)
- 23% (Teal)

Puerto Mosquito Bay
- 57% (Green)
- 5% (Blue)
- 11% (Yellow)
- 27% (Teal)
Land Use/Land Cover Map of Puerto Mosquito Bay Catchment

Legend

- Water
- Forest land
- Barren land
- Wetland
Index of Vegetation

Darker green color represent more density of vegetation
Validation process

- Accuracy is calculated by the sum of the number of pixels classified correctly divided by the sum of all the pixels in the entire ground truth classes.

- Confusion matrix for La Parguera Bioluminescence Bay
  - Ground Truth ROI’s, was 99%
  - Kappa coefficient was 0.80.
  - The Kappa coefficient is a measure of the proportional improvement by the 36 classifier over a purely random assignment of classes.

- Puerto Mosquito Bay
  - Ground Truth ROI’s 90%
  - Kappa Coefficient was 0.5

- The confusion matrix, using Ground Truth Image, was 100% and the kappa coefficient was 1 for both bays.
Discussion

- Supervised classification, the analyst has control of the selected classes depending on the purpose of the research.

- All supervised classifications were tested to determine the best spectral response for each image and classification method.

- For La Parguera Bioluminescence Bay, the percentage distribution was similar in the two bays, except for urban or built-up areas.
• In La Parguera Bioluminescence Bay has more interaction with anthropogenic activities than Puerto Mosquito Bay.

• It is visible to recognize that La Parguera Bioluminescence Bay has less density of vegetation than Puerto Mosquito Bay.

• The geological characteristic take an important role for the distribution and impute of sediments that effect into the bay.
Conclusion

- The capacity to recognize and updates these land use and land cover areas are important tools development of priorities for the management and for future research.

- The fact that the presence of the urban or anthropogenic activities affects the bioluminescent bays, also contribute to reduce the bioluminescent.

- Human activities have a substantial impact on the hydrology characteristic of the bay, also the sediment impute to the bay has been variable due to human activities.
The destruction of vegetation and the transit of boats can also affect the bay.

For future research, is suggested used older images and make supervised classification to determine changes in time and vegetation.

The IKONOS sensor is a great tool to obtain images with high quality, classification and index of vegetation was possible using the spectral information available in the images.

Webpage: http://gersview.uprm.edu/website/
Acknowledgments

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References