Land Cover as an Indicator of Climate Change in the Bowling Green State University Area

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Abstract

Using the GLOBE Program protocols for Land Cover and Climate, we set out to investigate three research questions: 1) What covers our land in the 15 km by 15 km area surrounding the BGSU Campus? 2) How has the BGSU land cover changed over time? and 3) Is the iPhone supporting the Simple GPS application as accurate as two other GLOBE certified GPS devices? Using satellite and aerial imagery, field observations, land cover classifications, global positioning system devices, photography, and thematic mapping techniques, we collected and analyzed our data. Our findings show that the region is predominately agricultural but the region has experienced a shift towards urbanization between 1994 and 2011. Shifts in land cover impact the climate and these climate changes will further influence land cover. iPhone devices running the Simple GPS application were found to be accurate as GLOBE certified devices.

Introduction

Land cover is what we observe covering the Earth's Surface. In a more direct sense, land cover concentrates on both man-made areas and natural growth (Di Gregorio & Jansen, 2000). We studied land cover because the data we collected can be compared to what is collected by other students and can be used by remote scientists to improve their land cover classifications. The information collected is also used in environmental analysis as researchers explore human and natural effects on the land. Land cover is exceedingly important to climate researchers. According to a study by NASA and NOAA, "changes in land cover, particularly vegetation, over the past 300 years have impacted regional temperatures and precipitation" (Jenner, 2006). With the changes in land cover and the rapid urbanization that has been occurring, monitoring the land cover is important for predicting the effects this urbanization might have on the climate and environment. We have concentrated our research in the Bowling Green community, which is a predominately rural area. The changes in rural and agricultural areas affect the climate and in return, future climate changes will affect land cover. Identifying land cover and monitoring these changes over time is therefore critical.

Materials

1. Initial 15 km x 15 km map of the Bowling Green area
2. Measuring device or knowledge of pace measuring
3. 4 types of GPS systems: Garmin Etrex, Magellan eXplorist, Simple GPS for two iPhones
4. MUC field guide or MUC field guide app
5. White board with marker
6. Compass (iPhone app)
7. Camera (iPhone)
8. Internet access
9. Multi Spec software (Thematic Maps)

Methods

RQ1:

1. Looked at Google Earth and Landsat images of the BGSU area to explore common land covers.
2. Found the center of our 30 m by 30 m square, this could be done by using a pacing method.
3. Found the GPS coordinates using our 4 different GPS devices: Garmin Etrex, Magellan eXplorist, Simple GPS for iPhone (Nikki), Simple GPS for iPhone (Dr. Haney).
4. MUCed (land cover type ID code) the area using the GLOBE's MUC Field Guide.
5. Took pictures in each of four directions (North, South, East, and West).
6. Submitted data and photos to the globe website.
7. Found Landsat images (http://earthexplorer.usgs.gov/) from June or July of three different years (1994, 2005, 2011) where we could find high quality images of our region (with less than 10% cloud cover for the months of interest). We imported the image layers into Multispec software to create thematic maps by conducting supervised clustering techniques to depict our MUC classifications and percentages for each time period. ***NOTE: We chose 1994 as the starting point, as it represents both the year we were born and the birth year of the GLOBE program. Moreover, change over time represents changes taking place during nearly our life span.***
    - Used Google earth images to compare to the Landsat image and identified the land cover
    - Identified and named at least 10 fields for each MUC
    - Classified and clustered each map and reviewed any possible inaccuracies
    - Ran statistics for each map to determine accuracy for the clustering techniques

- Adjusted the colors of the maps to be the same for all maps

RQ2:

Compared percentages for each MUC over the three time periods.

RQ3:

1. Collected latitude, longitude, and elevation data from 34 locations on the BGSU campus 5 paces apart using all four GPS devices mounted side by side on a large white board.
2. Conducted ANOVA tests (with Tukey post hoc analysis) on the latitude, longitude, and elevation data to see if iPhones with Simple GPS technologies were as accurate as GLOBE certified GPS units.

Results by Research Question

RQ1) What covers our land in the 15 km by 15 km area surrounding the BGSU Campus?

Our land cover consists of **10 types**, with agriculture being most dominant. Other land cover types include transportation, industry, residential, parks/recreational fields/cemeteries, deciduous forests, golf courses and other manicured grasses, open water, wetlands, and fields and prairies.

RQ2) How has the BGSU land cover changed over time from 1994 - 2011? The largest growth is in transportation, industry and residential areas. The largest decline is in fields and prairies, golf courses*, agriculture, and parks, recreational fields, and cemeteries .Overall, green spaces decreased by **38.9%** and non green spaces increased by **38.9%**.

RQ3) Is the iPhone supporting the Simple GPS application as accurate as two other GLOBE certified GPS devices? Yes: iPhones with the Simple GPS app is just as accurate for

Latitude, Longitude, and Elevation (and even more accurate than the Magellan eXplorist for elevation). There were no statistical differences for latitude or longitude. There were differences found for elevation, but the post hoc analysis revealed that the Magellan eXplorist 310 was the device that reported elevation values significantly different than the other three devices. The iPhone devices running the Simple GPS application were not statistically different from the Garmin Etrex device.

Discussion

RQ#1: There are multiple types of land that cover the Bowling Green area, mainly agricultural. With this information, we are able to identify how our land cover types affect carbon storage and climate (through temperature and precipitation). To limit climate impacts, identified green spaces should be monitored and sustained.

RQ#2: There was an increase in industry and residential areas (non green spaces) and a decrease in agriculture (green space) that indicates an increased carbon footprint for our 15km by 15km area around Bowling Green. Due to the increase in carbon output and decrease in carbon storage, regional temperatures will increase (Jenner, 2008) and biodiversity will be affected (Jetz, Wilcove, & Dobson, 2007).

RQ #3: iPhone devices with simple GPS applications can be used instead of the GLOBE certified GPS devices. This is revolutionary for the GLOBE program. Our results show that there is a readily available technology for everyone to use. People and classrooms all over the world will be able to easily and accurately collect GPS data for the GLOBE program and further enhance the world's land cover research.

Limitations & Future Studies: Throughout our research we faced multiple limitations with the Landsat images. Out of our three images, only one, 2005, was undamaged and a high quality Landsat 7 image. We had to use a Landsat 5 in 1994, since Landsat 7 images were unavailable before 1999, and again in 2011, because the Landsat 7 satellite began to "malfunction" in 2007. As a result, the Landsat 5 images had lower resolution and fewer "channels" to separate reflectance patterns. Land cover on the 2005 and 2011 images were more difficult to identify leading to an increase in error in classification. In the future, it would be beneficial to have high quality Landsat images to work with so we can guarantee that we are identifying the correct land cover types. NASA's launch of Landsat 8 last month will greatly improve the availability of high quality Landsat images for future study.

References:

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