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GEOG 474
Final Project
April 27, 2018

Growth and Change Detection of the 7-County Metro Area

The 7-County Metro Area is a major metropolitan area in the Midwest, and houses more than half the population of Minnesota. The metro area is home to the capital city of St. Paul, as well as the most populous city, Minneapolis. The 7 counties include Anoka, Washington, Ramsey, Carver, Hennepin, Scott, and Dakota. With increasing urbanization, and populations moving to the cities, this area has seen a heavy increase in population in the past few decades. In 1975 the population was at approximately 1.9 million, while in 2015 it was recorded at around 3.3 million; a near doubling of the population in 40 years.

The question of wanting to answer how much the metro has grown is based on the premise to see how the area is developing. With these increased populations, many areas are moving into an urban sprawl, which can have detrimental impacts on the environment and surrounding communities. A sprawl mindlessly expands without regard for much else than development. The goal of this project is that the remotely sensed data will show whether the metro area is continuing on a trend of sprawl, or if instead they are focusing on building within its limits and undergoing urban revitalization and gentrification. If this is the case, the rate of development will steady or slow down with an increasing population base.

Data and Methods

All of the remotely sensed imagery came from the internet, specifically USGS's GloVis web service. To use this website, you simply need a USGS account, and can choose from many different satellites and sensors to download from. Unlike USGS's Earth Explorer web service, there is no waiting for processing of images in GloVis.

In this project Landsat 1, 5, and 8 were used. Landsat 1 was used for 1975, Landsat 5 for 1985, 1995, and 2005, and Landsat 8 for 2015. Landsat was chosen due to its large coverage, free accessibility, and the spatial resolution was adequate for my purposes. Landsat has the great advantage of spectral resolutions, that are very helpful in classification schemes. For all the Landsat 5 images, I needed to download 2 separate swaths and mosaic them together in the MosaicPro tool of ERDAS Imagine (after stacking all the bands; explained later). A weighted seamline was used in MosaicPro to blend the overlap between the two images.

The final piece I had to download was a vector shapefile of the counties of Minnesota. This was downloaded from MNDOT's GIS data site and loaded it as a vector layer into ERDAS Imagine. Within the software I selected my seven counties. With all of them selected I went to the Vector Drawing menu, and selected Paste from Selected Object; this created an AOI layer of the 7 counties, which I saved.

With the data downloaded, and AOI created, the bands had to be stacked before clipping the study site. This was done with the Layer Stack tool (Raster -> Spectral -> Layer Stack). For Landsat 1, bands 4-7 were selected, and for Landsat 5 and 8, bands 1-7 were selected. In hindsight, band 1 of Landsat 8 was not necessary, as it is a coastal band. These were exported into single .img files. Other than mosaicking the necessary images, clipping was done next. This was done by the Subset tool (Raster -> Subset & Chip -> Subset). The inputs were either the stacked Landsat images, or mosaicked images, and saved output as desired. On the bottom of the menu, AOI was selected, and chose the 7-county AOI made from the vector layer. With the images clipped, the final step of classifying the images can be done.

The classification method used was supervised. 5 classes were used: water, urban, suburban, cropland/non-urban, and forest area. 8 training polygons were used per class and merged together. The values were recoded 1-5, respectively. This was done with all 5 dates and output all the classification maps. The final procedure was to conduct accuracy assessment on the maps. For this process, 50 random points were used. The results of the accuracy assessment will be elaborated in the results and discussion.

Results and Discussion

The results, though with some errors, showed a large increase in growth of the metro area in the past 40 years. A clear sign of this was the final change detection map by using the Matrix Union tool between the 1975 classified map, and the 2015 classified map (See Figure 1). The yellow indicates change from non-urban to suburban, and red indicated non-urban to urban. There was a total change of non-urban to suburban/urban of 400,360 acres.

Figure 1: Change Detection

The area of error comes with some of the acreage amounts that came out (used the "add area" table function). In the case of 1975, it was 450k acres, then dipped to 322k acres in 1985, back up to 590k acres in 1995, and back down to 481k acres in 2005; ending at 705k acres in 2015. There is definitely some mistake when looking at these numbers, as the border of urban area continually grows throughout the years. It is thought that the little differences in classification, training polygons, and even resolution may have caused some differences in numbers. Little errors and misclassifications throughout the whole study area may have added up to big differences. Because of this, it seems much more effective to look at the question of where this change happened, compared to the question of when.

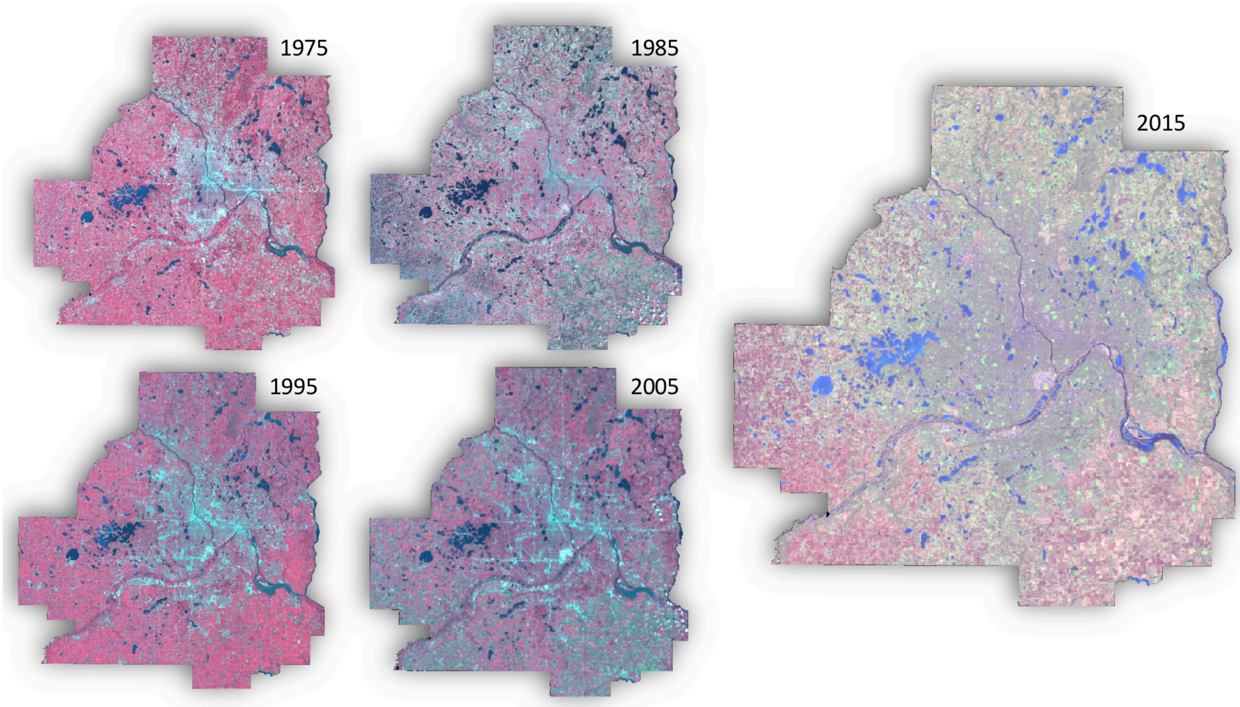

Figure 2: Landsat subsets

This issue could possibly be mitigated through better understanding of the landcover, leading to more accurate and detailed classification. On that note, use of more training polygons, etc. using higher resolution satellite imagery, and utilizing tools like Feature Analyst, an object-based classifier, would have yielded more accurate results. These options do come with their downfalls, though. As you enter into the realm of high resolution images, they can begin to cost money (in many cases not cheap) and take up lots of data.

Finally, looking at the accuracy assessment, there was mixed feelings. Overall, they were acceptable, and in many cases 'perfect'. Because only 50 points were used per image, very few of those points were on urban/suburban lands. Many of the points landed on rural landscapes and fields. This made it fairly easy to classify, but in a way defeated the purpose of the assessment. If there was a misjudgment on one urban point the accuracy would be 50% or lower in some cases due to only having 2 points on urban. The overall accuracy for ranged from

78% to 92%, meaning something was done right. But with saying that, it may have been wise to select more points, giving me a greater representation as a whole. This is where I believe the little things adding up to a big difference could have been seen. Using more points and getting more detailed assessments would have proven whether that was true or not.

Conclusion

Even though there were multiple errors in classification, and number outputs; it's very clear the trend of growth. The metro area is increasing in size, either at a steady rate, or slightly slowing. The only points used for this rate of increase were 1975, 1995, and 2015. Because of the errors of acreage outputs for 1985, and 2005 they were emitted. Compared to the population, which has seen higher rates of growth in the present decade or too, the urban growth of the area may not be matching it (See **Figures 3 & 4**). This could indicate a promising fact that either the metro area is hitting its limits of growth, or there is a focus on urban revitalization and gentrification. This could be forced by policies and restrictions like Urban Growth Boundaries, literally limiting the amount of sprawl an urban area can do. As explained in the introduction, limited urban sprawl is a great sign for the future of the surrounding community. Whether that be forest and wildlife species, or the crop fields surrounding the metro; a halt to such a destructive nature helps all the more.

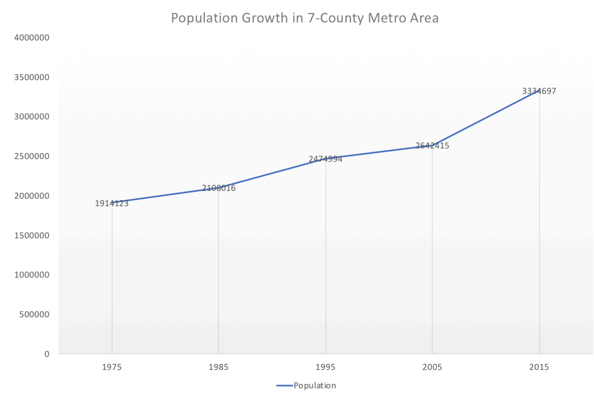

Figure 3

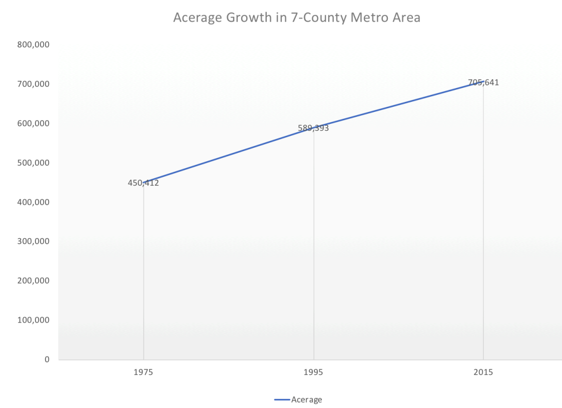

Figure 4

Though it may seem obvious that the metro area is growing; simply look at a map, and population numbers. But the real power that remote sensing gave us, is clear, defined areas of growth, and change. By using other forms of satellite or aerial photography, so much more can be continued with these questions. There is so much depth when it comes to how humans use the land, and feel this is only the foundation of where to being.

This study opens the door to more detailed analysis of urban growth of the metro area. With more detailed imagery, and more understanding of the area as a whole, much more accurate classifications can be done. With more data points used it becomes much easier to pinpoint trends, and act upon those. I definitely feel there is a trend shown in the results gained from this study, but not as precise as hoped.

On a personal note, I have expanded my knowledge of ERDAS Image by quite a bit. The repetitive motion of doing these tasks, and fixing errors and mistakes made me understand the function of some of the tasks I just ‘did’ in labs. I don’t feel I have scratched the surface of the software yet, which is exciting; as it can do so many powerful analysis tasks, and answer so many tough questions.

Works Citied

MNDOT. "MNDOT Data 2017." Minnesota Department of Transportation. https://www.dot.state.mn.us/maps/gdma/gis-data.html

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