Oregon State University
College of Engineering

Green Space changes at OSU campus from 2007 to 2015

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1. Introduction

Oregon State University has been expanded many times since its inception. Its area also makes the OSU Corvallis campus the tenth largest campus in the United States. In the last decade, the campus has also built many new buildings, roads and other facilities. Whether these new buildings will reduce the green space of Oregon State University is a concern for students and fits into sustainable development. This project uses ArcGIS Pro to analyze the change of the green area of Oregon State University from 2007 to 2015, and draws the change of the green area of the OSU Corvallis campus.

ArcGIS Pro can classify pervious and impervious areas, calculate the area, and analyze its accuracy. By observation of the polygon, the green space changes and error of automatically classify can be determined.

Figure 1. Aerial view of OSU

2. Background

Sustainable development and reducing carbon emissions are global issues. Analyzing the changes in the green area of the OSU campus can analyze issues such as global warming and increased carbon dioxide content from around, and more intuitively feel the negative changes the earth is facing.

3. Site Description

Oregon State University Corvallis campus, is the campus where the most OSU students living and learning. It’s located at Corvallis, Oregon State, with an area of approximately 400 acres. The main project site is located at OSU Dixon Recreation Center, Reser Stadium, Parking Structure, Arnold Bistro, etc, which is shown as Map 1 on appendix. The imagery size depends on photogrammetry of 2015 OSU photo size.

4. Data Sources

The data is provided by CE561(Photogrammetry), one imagery is 2007 campus photography data, the other one is 2015 campus photogrammetry survey data.

5. Methodology

The software used to complete this project is ArcGIS Pro. The data set contains two imageries, one for photogrammetry in 2007 and one for photogrammetry in 2015. Create a new project in ArcGIS Pro and use Add Data to add two imagery.

5.1 Georeferencing

After the data is added to the software, because there is no georeferencing, the data coordinates do not match the geographic coordinates, so the first thing to do is to imagery georeferencing separately.There are many methods of Georeferencing and many software can be used. In this project, roughly georeferencing was used.

First, zoom in to the imagery which needs to be georeferenced, change to base map to Imagery, click Imagery, and click the Georeference tool in the Alignment pane to start georeferencing. Then, move the image to a roughly corresponding location on the map, the transparency could be changed to 30% to 50%, which is easier to find the right location. Once the imagery has been moved to the right location, use the Import Control Point tool, Left-click the selected control point in the imagery and base map, respectively.

For the selection of control points, the entire imagery should be covered as much as possible, 6 to 8 control points are good.The point distribution is shown in Figure 2. The red and green circles are the control points on the base map and the control points corresponding to the imagery, respectively.

Figure 2. GCPs on base map and imagery

5.2 Resample

After the data is added to the software, check the file properties to determine the cell size of the file. The cell size of the two data is shown in Table 1.

Table 1. Cell size of Data set

Data ID	Cell Size of X	Cell Size of Y
2_6.tif (2007 Photogrammetry)	0.180789918829046	0.181156568117984
02_38.tif (2015 Photogrammetry)	0.0827256936981787	0.0822658369137412

As shown in table 1, cell sizes are too small and will increase the workload of classification, so use the Resample tool to change the cell size of the two pictures to ensure the successful completion of classification.

Click Analysis and click Tool, on search box input Rasample, now Resample tool can be used. In resample tool, the “input raster” should be the imagery that needs to be resampled, output raster dataset is the name of imagery that output of resample. For X and Y, the 1(meter) should be put in, then click run, after processing the imagery with 1 meter cell size is generated.

5.3 Classification

To distinguish between impervious and impervious data, the Classification Wizard will be used. Zoom in to the layer that is imagery needs to be classified, click Imagery, click the Classification Wizard tool, and classify the two images in order. The supervised classification method is used due to indicate what types of pixels or segments should be classified in what way.

The object based classification type uses a process called segmentation to group neighboring pixels based on the similarity of their spectral characteristics. For Classification Schema, choose Use default schema.

Then click next to set segmentation. For Spectral detail, set to 12, for Spatial detail, set to 8, for Minimum segment size in pixels, set to 20. Those parameters decide how imagery will be grouped, in view of classification of impervious and pervious area, those parameters should be lower.

Then click next, the Training Samples should be set. Delete all classes and create new classes in order, named “Pervious” and “Impervious”. Then right-click “Pervious” and “Impervious” to create sup-class for them. The pervious should contain “Grass” class and “Forest” class, the impervious should contain “Road”, “Roof” and “Ground”, assign them with different color and value. Then click the Roof class to select it. Then, click the Polygon button. Now draw polygon on map as much as you can, because there are so many buildings in this data, the more drawn the precise samples could be made. After drawing, click Collapse to mix them. The steps are the same for other classes. Then click next to classify.

After the first classification, the all class should be shown on map, check all classes, if there is error in some class, back to the last step and draw those classes clearier. If classification is good, all classes should be merged, Road, Roof and Ground should be merged to Impervious, Grass and Forest should be merged to pervious.

5.4 Assess Classification Accuracy

To analyze accuracy of classification, the accuracy assessment point should be created. First, use the Tool in Analysis, search Create Accuracy Assessment Points tool, For input, choose the classification map which outputs from the Classification Wizard, set the Target Field to Classified, set the Number of Random Points to 100. Then click Run.

After creating accuracy points, right-click the points layer and choose Attribute table, change GrndTruth to either 40 or 20, which the position of the corresponding point is impervious or pervious.

Then using the Compute Confusion Matrix tool, input the accuracy points which were made, the accuracy matrix table is generated.

5.5 Calculate the green space area

To calculate the green space area, the Raster to Polygon is going to be used. Search Raster to Polygon in Tool, input Impervious map, create a polygon layer for each impervious. Then using Select by Attributes on Map pane, for Input Raws choose the polygon layer were made, add a new expression, set the gridcode is equal to 40, click run. Now the impervious area can be calculated by attribute a table.

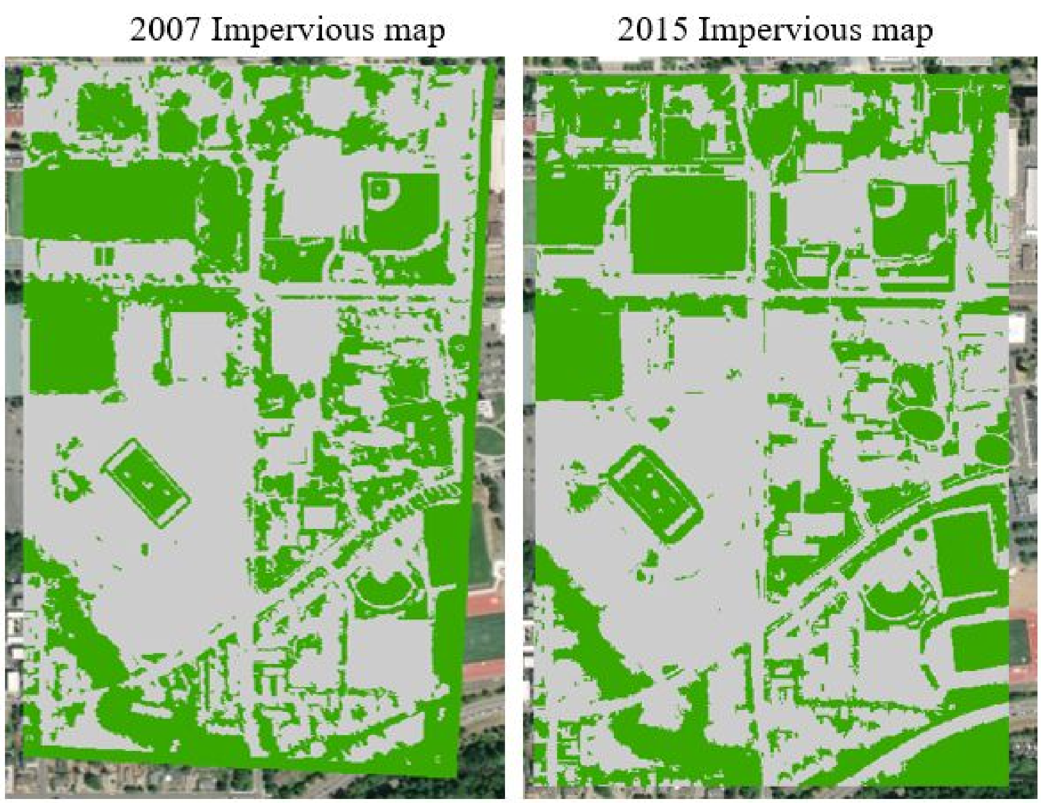
5.6 Raster calculator

For the raster calculator, the direct information of changes between 2007 to 2015 could be displayed. Search Raster Calculator in the Tool box, set the parameters as

["OSU2015_Classification_Clip" "OSU2007_Classification_Clip"]. Then click run, the new layer is made to analyze the changes, also the shadow and other errors could be found.

6. Result

Figure 3. Comparison of 2007 and 2015 Impervious map



As shown in figure 3, the biggest change from 2007 to 2015 occurred in the upper left corner of the map, which is the area near Dixon.

Table 2. Matrix table of 2007 dataset accuracy points

OBJECTID	ClassValue	C_4	C_20	C_40	Total	U_Accuracy	Kappa
1	C_4	0	0	0	0	0	0
2	C_20	0	43	0	43	1	0
3	C_40	1	0	56	57	0.982456	0
4	Total	1	43	56	100	0	0
5	P_Accuracy	0	1	1	0	0.99	0
6	Kappa	0	0	0	0	0	0.979835

Table 3. Matrix table of 2015 dataset accuracy points

OBJECTID	ClassValue	C_20	C_40	Total	U_Accuracy	Kappa
1	C_20	43	0	43	1	0
2	C_40	0	57	57	1	0
3	Total	43	57	100	0	0
4	P_Accuracy	1	1	0	1	0
5	Kappa	0	0	0	0	1

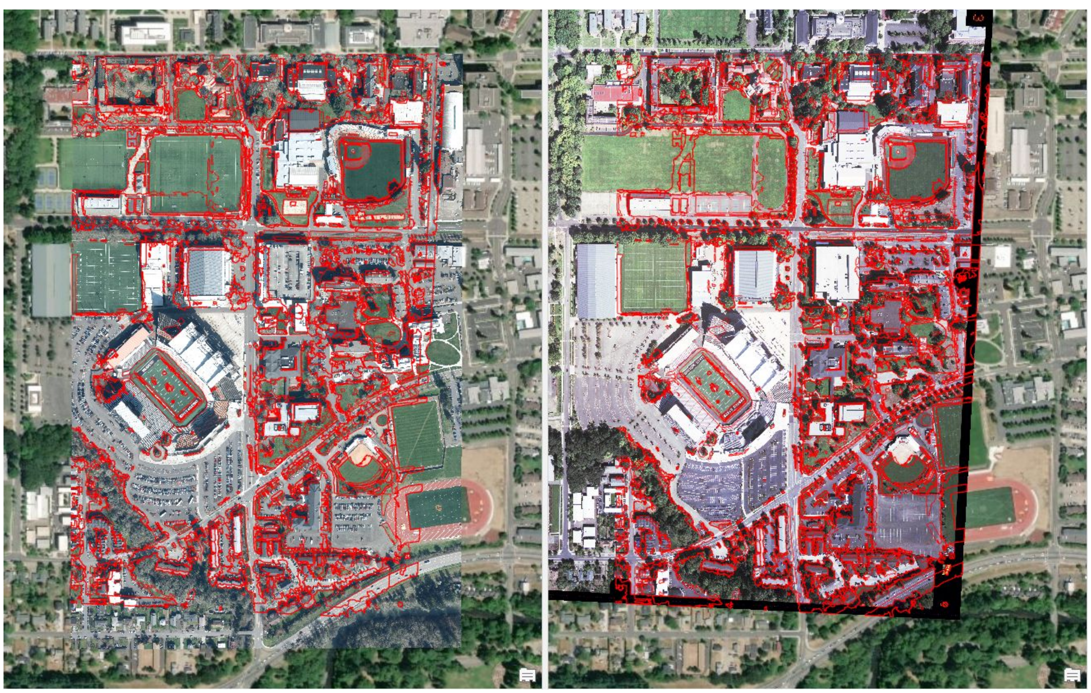
Table 2 and Table 3 showed the accuracy of impervious and pervious classification. The 2007 matrix table shows 56 points that had a ground truth of 40, while 1 point with a ground truth of 40 was misclassified as 20. Kappa value of 2007 matrix table is 0.9798, which is higher than 0.92, and Kappa value of 2015 matrix table is 1, so the accuracy of impervious classification is acceptable.

Table 4. Comparison of impervious area in 2007 and 2015

	Impervious Area(m^2)	Pervious Area(m^2)
2007 Campus	653814	491302
2015 Campus	698060	447056
Area changes	44246	44246

As shown in Table 4, between 2007 and 2015, the area of green space decreased 44,246 m^2 .

Figure 4. Raster calculator map compare with 2007 and 2015 photogrammetry



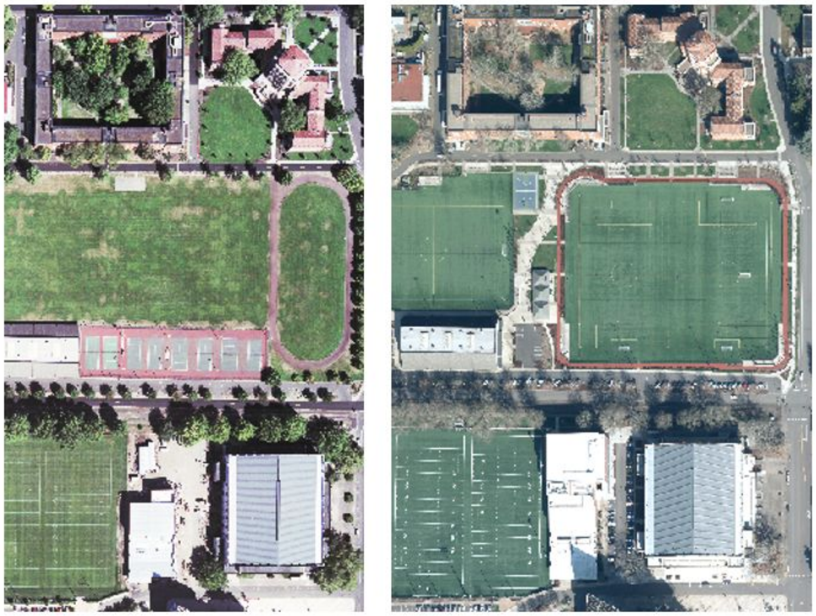
As shown in Figure 4, the red line marks the area that has changed. The total change area is 841,117 m^2 . Comparing it with photogrammetry can find clearer changes, and you can also find errors in classification. For example, some shadow changes are classified as impervious areas, and some buildings are classified as green areas.

7. Discussion

This is largely due to the construction of football and tennis courts, which is shown as figure 5. At the same time, a new beach volleyball court has been constructed on the lawn on the south side of Dixon, which is shown as figure 6. In 2007, west of Dixon was a large lawn and runway. After construction, the indoor tennis court occupies part of the green space, and the road construction around the soccer ball field also occupies part of the green space. Observation found that the roads in campus have also been renovated and they have become wider, so this may also be the reason for the reduction in the area of green space.

Figure 5. Comparison of South Side of Dixon in 2007 and 2015 (beach volleyball court)

Figure 6. Comparison of West Side of Dixon in 2007 and 2015 (Soccer ball court)



8. Errors

Through observation and analysis, errors mainly occur in classification. Due to the high definition of the photo in the photogrammetry and the composition of the color spectrum, when segmenting, low segmentation prevents many details of the photo from being clearly displayed. Moreover, some colors were incorrectly classified, such as the colored lawn in Reser Stadium was marked as impervious. Furthermore, in the classification, there is no shadow class added, so some shadows in the photo are also incorrectly classified into impervious or change.

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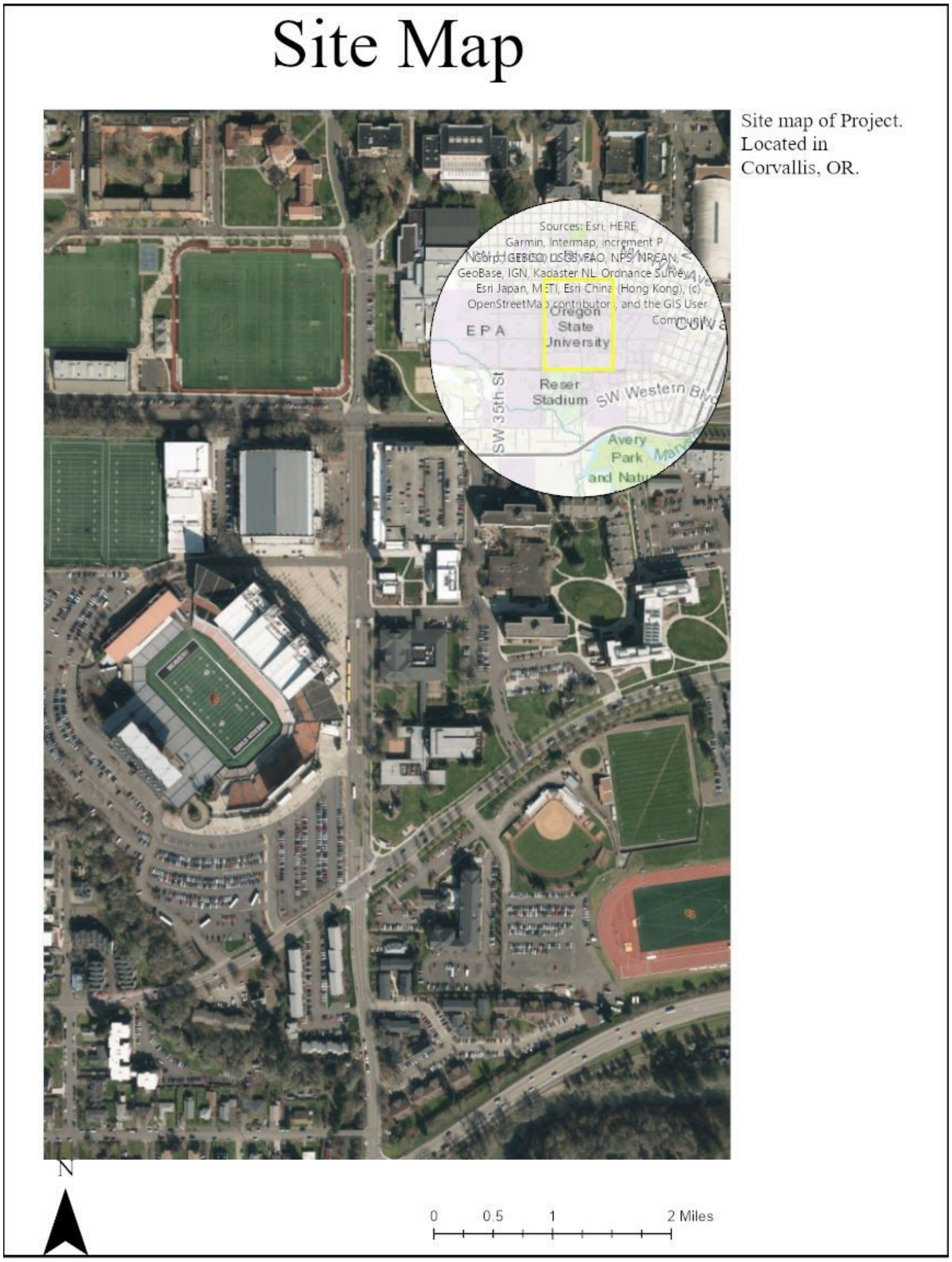
Reference

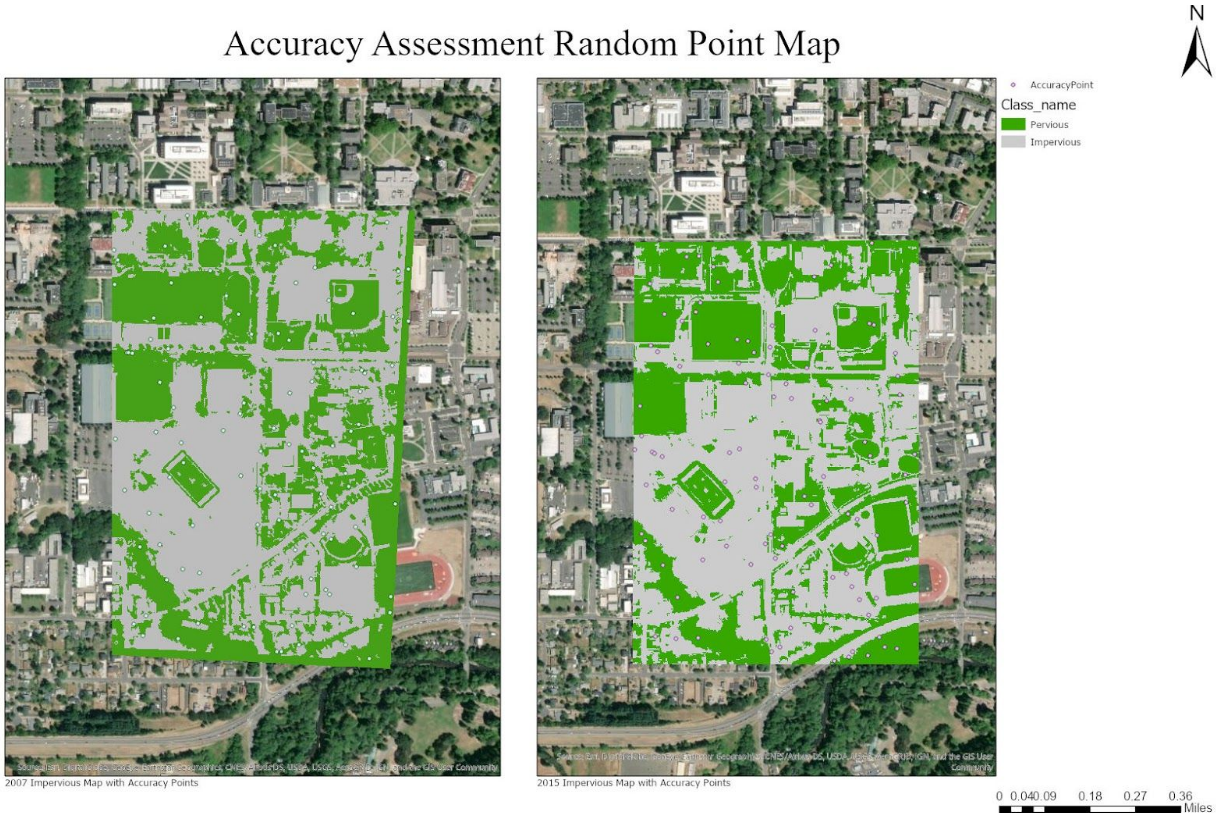
Viswambharan, Vinay. "Calculate Impervious Surfaces from Spectral Imagery." *Learn ArcGIS*, Eris, learn.arcgis.com/en/projects/calculate-impervious-surfaces-from-spectral-imagery/.

Appendix

Map 1. Site Map



Map 2. Accuracy Assessment Random Point



Map 3. Raster Calculation Changes and Photogrammetry Comparison Map