Urban an Agricultural Expansion in Nanaimo

1 STUDY AREA AND DATA SOURCES

The main area of study for this project is the city of Nanaimo, BC, Canada. Located in the east coast of Vancouver Island, at 49° 9′ N, 123° 56′ W. With a metro area of 1,281km^2 and a metro population of 98,021 people [1]. This paper will examine the urban expansion and land use and land change between the years 1986 to 2014. The data required would be satellite imagery of the city from these two years. The images chosen were two Landsat images. One Landsat 5 image from August 8, 1986, and the remaining image from Landsat 8 on September 2, 2014. The images are a month apart but provided the best solution to minimizing cloud cover, and being close in season.

Fig. 1 Landsat 5 image of the city of Nanaimo, BC from August 8, 1986. The image is displayed using band 345 (Red, Near Infrared, and Mid-Infrared respectively)

2 DATA METHODS AND ANALYSIS

Analysis for the scenes began by displaying the images in band 345 for Landsat 5, and bands 456 for Landsat 8. This increased the contrast and enabled for greater visual interpretation of the city, and its surroundings. The areas of dark purple include the urban areas such as houses, roads, and industrial areas. As well rocky areas along the coast, and outcrops throughout the landscape.

Fig. 2 Landsat 8 image of the city of Nanaimo, BC from September 2, 2014. The image is displayed using bands 456 (Red, Near-Infrared, Mid-Infrared respectively).

These are all areas of low reflectance where most of the infrared energy is absorbed as opposed to reflected. The green areas highlight vegetation. The more green the vegetation the more reflection. Darker green areas are coniferous forests. As noticed by both images the area surrounding Nanaimo is primarily coniferous. With the lighter green areas being field from previous logging, and agriculture. The light pink areas indicate dead vegetation, in the absence of development. This is again primarily due to logging, and the clearing of land for agricultural use.

The next step in evaluating the cities change is classification. For this project supervised classification was used on bands 345 for 1986, and 456 for 2014. Both classifications also included a shadow reduction ratio, 4/3 for 1986, and 5/4 for 2014. Nine classes were chosen for this classification.

1. Urban – Light Green
2. Industrial - Yellow
3. Water - Blue
4. Shallows – Light Blue
5. Deciduous Forest - Green
6. Coniferous Forest – Dark Green
7. Deciduous/Field – Pale Green
8. Agriculture - Magenta
9. Cut blocks/Rocks – Pink

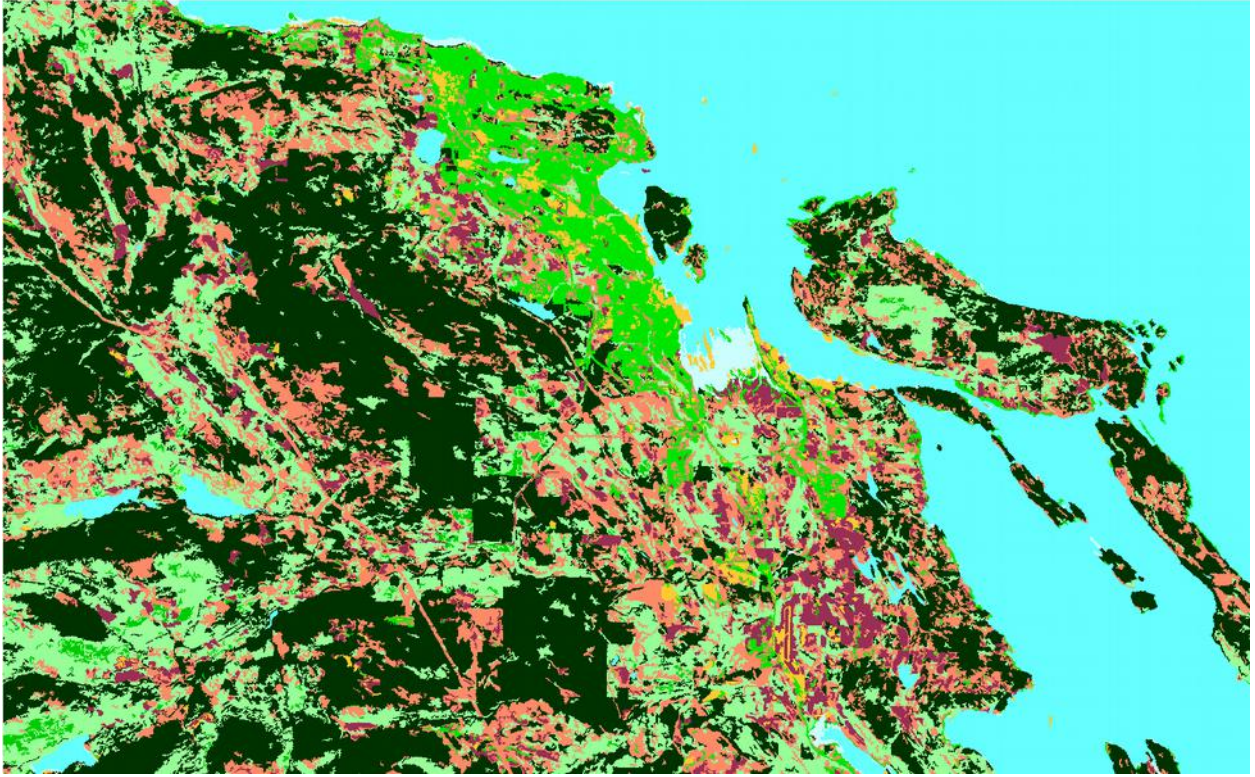Fig. 3 Classified and Sieved image of Fig.1

Fig. 4 Classified and Sieved image of Fig. 2

Due to their similarity in reflectance it was practical to group both cut blocks and rocky areas into one class. Once the images were classified and sieved the four main classes of interest were isolated. These areas included urban, industrial, agriculture, and cut blocks/rocks. These four areas are able to show the total urban expansion for the city, as well as areas of deforestation. The areas were isolated by using the EASI Modeler to create bitmaps for the desired areas. The bitmaps were then run through the BIT2POLY tool to obtain a set of polygons from each area. From these polygons a total area would be able to be obtained.

3 RESULTS

Fig. 5 Nanaimo 1986. Urban in Green, Industrial in yellow, Agriculture in Pink, Cut blocks/rocky areas in purple.

	1986	2014
Urban	57.26	100.79
Industrial	18.71	14.8
Agriculture	38.96	51.46
Cut blocks/Rocks	90.64	173.66

Table 1. All units are in km^2

Table 1 shows the extent of change between the classes from 1986 to 2014. In 28 years the city of Nanaimo has almost doubled in size with a slight change in the total industrial areas. The slight change in industrial areas could be attributed to errors in classification. The area in the south-west corner of Fig. 5 is a good example of this. In reality it is a freshly logged area.
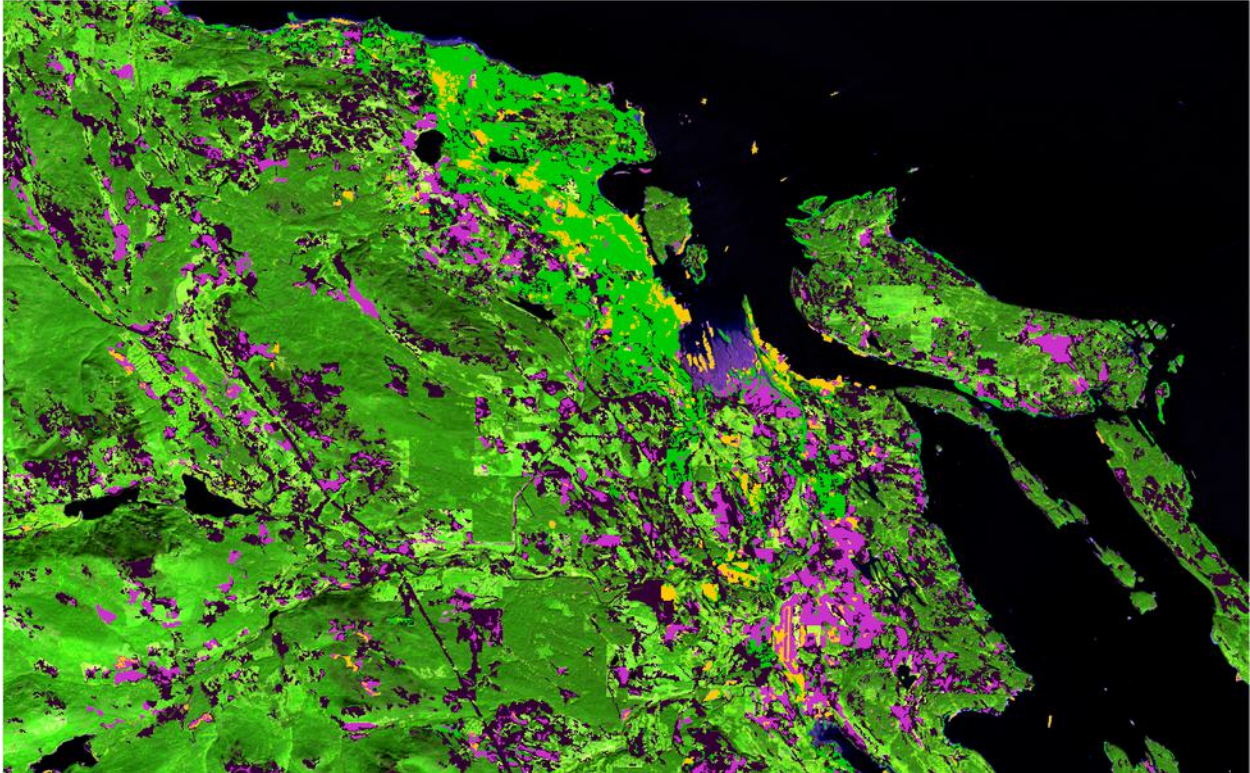
Fig. 6 Nanaimo 2014. Urban in green, Industrial in yellow, Agriculture in pink, and cut blocks/rocky areas in purple.

Agriculture also saw an increase in total area use. Primarily to the south of Nanaimo around the airport. The most surprising of all the classes was the cut blocks class. The increase in deforested areas from 1986 to 2014 increased dramatically. This is evident not only in the cut block class but the deciduous and field class, even though visual analysis on the pre-classified images.

One of the difficulties encountered was that the rocky beach front areas were incorrectly classified as urban areas. This is clearly noticeable on the northern tip of Gabriola Island, the largest island to the east of Nanaimo. This was caused by the two class's similarity in reflections of infrared energy. Due to the similarity in reflection no viable solution could be used to separate the two classes. In the case of the cut blocks/rock class, most rocky areas contain rock covered by moss or grass enabling for different classifications. Another issue was the inclusion of logging rafts, and ship being included in industrial class. While they're relevant, they are not static objects. As is evident by the difference between the two scenes that shipping and logging are dynamic.

The supervised classification provided a clear avenue for exploring urban expansion, and land use and change. The change that the city of Nanaimo and its surrounding area have gone through is noticeable. From large urban expansion, to greater agricultural use, and greater deforestation. Reference

Reference:

[1] Stats. Canada (2015, April 17). *Population and dwelling counts, for Canada, provinces and territories, and census subdivisions (municipalities), 2011 and 2006 censuses* [Online]. Available: http://www12.statcan.gc.ca/census-recensement/2011/dp-pd/hlt-fst/pd-pl/Table-Tableau.cfm?LANG=Eng&T=302&SR=1&S=51&O=A&RPP=25&PR=59&CMA=0