Land Change Detection Using Cross Correlation and Sensitivity Analysis

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Introduction

In this study, a pilot study of land cover change was carried out in Beijing metropolitan area during the period of 2010-2015, adopting 2010 classification map and 2015 Landsat image,sensitivity analysis was used to understand how the accuracies of decision change in response to different thresholds.

Background

LUCC datasets are increasingly used as primary data source for global and regional scale assessments. Among various change detection methods, two groups are categorized by many researchers. In this study, the two groups were simply termed as “pre-classification methods” and “post-classification methods”.

Materials & Methodology

- Data and Study Area

Two types of data were used in this study: 2010 classification map and 2015 Landsat8 OLI image covering the same selected Beijing metropolitan area (Figure 1).010 classification map was achieved from the Globaland30 - “30 m Global Land Cover (GLC) data product”, which is a global dataset with level 1 land cover classification scheme based on the year of 2010 (Globaland30, 2016). And the Landsat8 OLI image (2015-04-16) was downloaded from the USGS website (USGS, 2016).

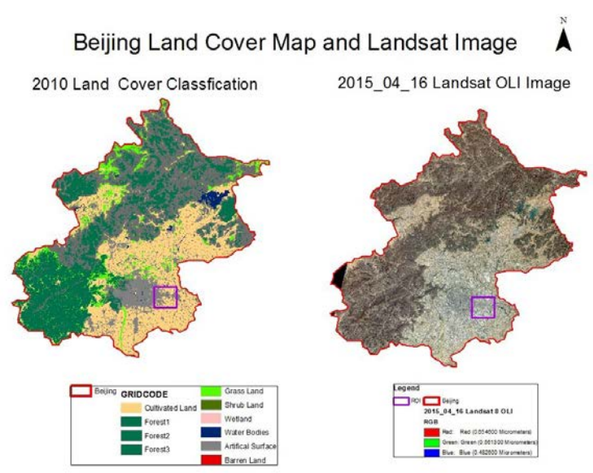

Figure 1 Beijing thematic map and rea with test area

- Methodology

There are two main parts in the flowchart (Figure 2): cross correlation and sensitivity analysis. Cross correlation is a method that evaluates the differences between a Date 1 classification map and a Date 2 image (Koeln and Bissonnette, 2000; Civco et al., 2002). Sensitivity analysis, which is used to explore how the result changes in response to variations from input and how they interact, was followed to evaluate the accuracy of change decision using different thresholds.Five steps were implemented for cross correlation calculation and sensitivity analysis.

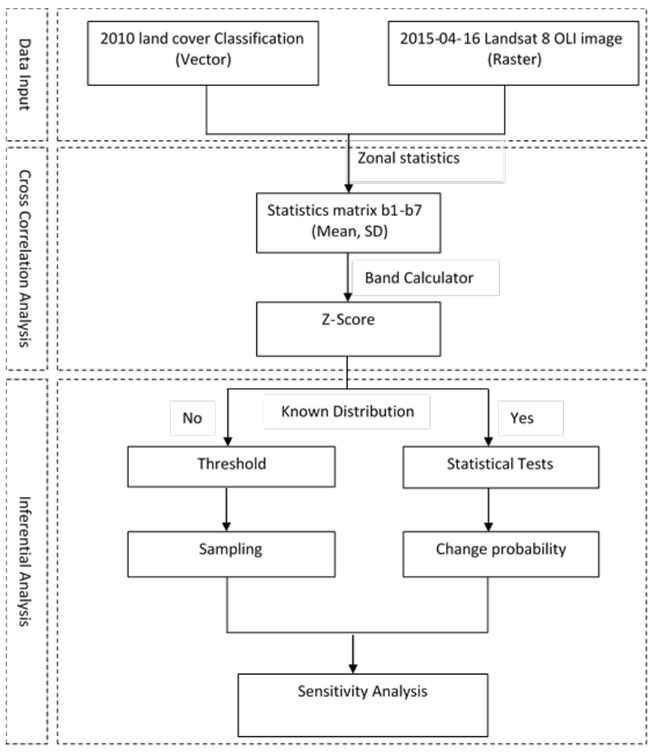

Figure 2 the flowchart of methodology

Results

The mean values of three land cover types show that: water has lower reflectance than cultivated land and artificial surface in all the seven bands.The SD values of three land cover types show that cultivated land has greater dispersion in visual bands (B1-B4) and lower dispersion than water at infrared band (B5-B7).

Land Cover	ID	Band1		Band2		Band3		Band4		Band5		Band6		Band7	
		μ1	σ1	μ2	σ2	μ3	σ3	μ4	σ4	μ5	σ5	μ6	σ6	μ7	σ7
Cultivated Land	1	16.4	2.9	15.3	3.5	14.1	3.3	15.0	4.3	23.4	4.7	22.9	6.5	19.5	6.9
Water	2	13.5	2.0	11.6	2.5	9.7	3.1	8.8	4.2	11.5	8.0	9.7	7.9	8.1	6.7
Artificial Surface	3	16.2	2.1	15.0	2.6	13.5	2.6	14.3	3.5	20.3	4.5	19.7	5.7	17.2	5.7

Table 1 the mean and standard deviation of image DN values of each land type

Judging from the curve of histogram, majority of pixels is within a narrow span from zero.

The statistics of z-score of three land cover types were explored.

The decision of change and no change mainly is based on the usage of land, for example, from the barren soil to factory, or from the building to the barren land.

There are two classes in these error matrixes: “0” denotes no change, “1”denotes change. There are three types of accuracy: overall accuracy, producer’s accuracy for each type (change, no change), user’s accuracy for each type (change, no change).

Class Name	Predict	Truth 0	Truth 1	Percent	Number
No Change	0	67	6	0.92	73
Change	1	21	6	0.22	27
	Percent	0.76	0.5	0.78	Total: 100

Table 2 Confusion matrix with threshold (2000)

Class Name	Predict	Truth 0	Truth1	Percent	Number
No Change	0	73	8	0.90	81
Change	1	15	4	0.21	19
	Percent	0.83	0.33	0.80	Total: 100

Table 3 Confusion matrix with threshold (3300)

Class Name	Predict	Truth 0	Truth 1	Percent	Number
No Change	0	78	8	0.91	86
Change	1	10	4	0.29	14
	Percent	0.89	0.33	0.85	Total: 100

Table 4 Confusion matrix with threshold (4600)

Discussions

- Classification Map as Baseline?

Cross correlation method could be used as the baseline of change detection. However, the uncertainties in classification map can deviate far from this primary assumption.

- Z-score or Chi Square Statistic?

Z-score is defined as the sum of square of n standardized variables. Another problem is the redundancy among multi-spectral images.

- Unbiased Random Sampling?

Random sampling was carried out in the test area.The characteristic of a sample, should reflect population characteristic, or population statistics.

- Perfunctory Sensitivity Analysis?

Superficially, three trends were identified form the confusion matrixes. Is SA perfunctory?

Conclusion

In a nutshell, the technical solution to produce the NLCD by USGS is practicable by adopting paired images as the main data source and classification map as ancillary data source in land cover change detection.

References

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