EVALUATE THE CAPABILITY OF LANDSAT8 OPERATIONAL LAND IMAGER FOR SHORELINE CHANGE DETECTION /INLAND WATER STUDIES

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ABSTRACT:

This paper explored the capability of Landsat-8 Operational Land Imager (OLI) for post classification change detection analysis and mapping application because of its enhanced features from previous Landsat series. The OLI support vector machine (SVM) classified data was successfully classified with regard to all six test classes (i.e., open land, residential land, forest, scrub land, reservoir water and waterway). The OLI SVM-classified data for the four seasons (i.e. winter, spring, summer and autumn seasons) were used for change detection analysis of six situations; situation1: winter to spring seasonal change detection resulted reduction in reservoir water mapping and increases of scrub land; situation 2: winter to summer seasonal change detection resulted increase in dam water mapping and increase of scrub land. winter to summer which resulted reduction in dam water mapping and increase of vegetation; situation 3: winter to summer seasonal change detection resulted increase in increase in open land mapping; situation 4 : spring to summer seasonal change detection resulted reduction of vegetation and shallow water and increase of open land and reservoir water; situation; 5: spring to autumn seasonal change detection resulted increase of reservoir water and open land; and Situation 6: summer to autumn seasonal change detection resulted increase of open land . OLI SVM classified data found suitable for post classification change detection analysis due to its resulted higher overall accuracy and kappa coefficient.

1. INTRODUCTION

Remote sensing provides temporal classification of inland water studies (Gardelle et al., 2010; Prigent et al., 2012; Zhang et al., 2015). Landsat-8 Operational Land Imager; OLI due to better technical design is more appropriate for mapping application as compared to previous Landsat series (Irons J. R., Dwyer J. L. Barsi, J. A., 2012; Markham, B. L. et al., 2010; Pehlevan, N., Schott, J. R., 2011; U.S Geological Survey, 2012). Landsat-8 OLI provides efficient mapping application than Landsat-7 and earlier series (Czapla-Myers, et al., 2015; Flood, N., 2014; Jiag, P., Li, Feng, Z., 2014; Knight, E., Kvaran, G., 2014; Ke, Y., et al., 2015; Pervez, W., 2016; Morfitt., R., 2015; Markham, B., 2014; Roy D., et al., 2014. This paper presents a post classification change detection study of Landsat-8 Operational Land Imager (OLI) data classified by SVM of the study area for the four seasons. Change detection methods employed depends upon its application (Almutairi, A., Warner, T. A., 2010; Hecheltjen, A., Thonfeld, F., Menz, G., 2014. The objective of the paper was: (i) to evaluate OLI data using SVM classification for the four seasons (i.e. winter, spring, summer and autumn seasons) ; (ii) to evaluate seasonal change detection analysis of six situations from the four season OLI data.

2. STUDY AREA AND DATA SETS

This paper describes seasonal change detection analysis of OLI data using SVM classifier for the four seasons. OLI data parameters of the study area are shown in Table 1.

Table 1 : Imaging geometry conditions and scene center latitudes and longitudes for Landsat-8 OLI

	23 Nov 2015	30 Mar 2015	20 Jul 2016	8 Oct 2016
Sensor Altitude	705 km	705 km	705 km	705 km
Off-nadir/Nadir	Nadir	Nadir	Nadir	Nadir
Sun Azimuth	159.83º	139.19°	115.7 º	152.67 º
Sun Elevation	33.83 º	53.88°	65.92 º	47.08 º
Scene center latitude	33.10 º	33.10°	33.10 º	33.10 º
Scene center longitude	72.52 º	72.52°	72.53 º	72.53 º

3. RESULTS AND DISCUSSION

3.1 OLI Data Classified using SVM Classifier

OLI data was classified using SVM classifier. Figure 1 shows OLI data of the four seasons (i.e. winter, spring, summer, autumn) classified using SVM classifier.

3.2 Experimental Setup

Fol values were set for experimental setup:
Kernel parameter gamma (γ) =1/No of bands= 0.143
Penalty parameter C = 100
pyramid parameter = zero
classification probability threshold = zero

High resolution imagery is used for establishing region of interest.

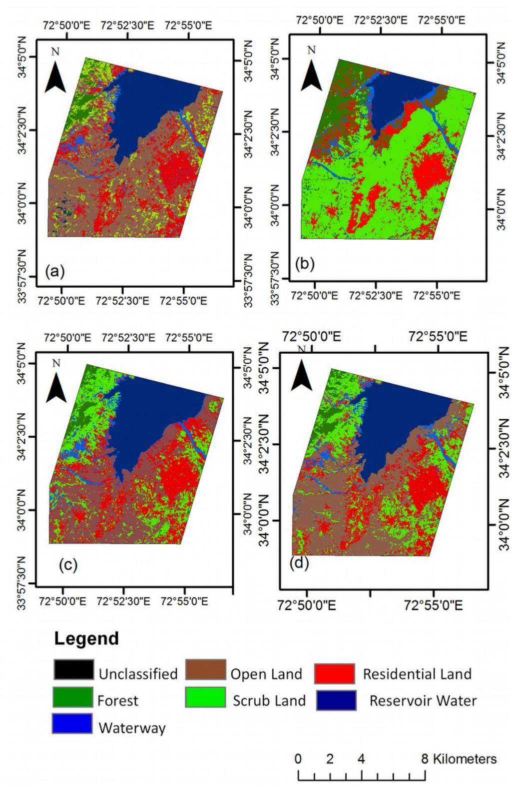

Figure 1. OLI data classified by SVM (a) winter (23 November, 2015), (b) spring (30 March, 2016) (c) summer (20 July, 2016), and (d) autumn (8 October, 2016)

3.3 Seasonal Change Detection from Winter to Spring

Change detection matrix (Table 2) from winter to spring shows decrease of spatial mapping of Open Land 64.37%, forest 80.96%, Residential land 30.79% and increase of waterway 40.08 %, scrub land 170.01% and reservoir water 128.04%. Figure 2 shows a change of category from reservoir water to waterway, reservoir water to Scrub land, and reservoir water to open land. Similarly, a change of category from open land to scrub land, scrub land to forest, residential land to scrub land and residential land to open land resulted increase of bushes in spring from winter. Similarly change of category from forest to reservoir water and scrub land to open land also resulted due to seasonal change. Change detection from winter to spring resulted reduction in reservoir water mapping and increases of scrub land.

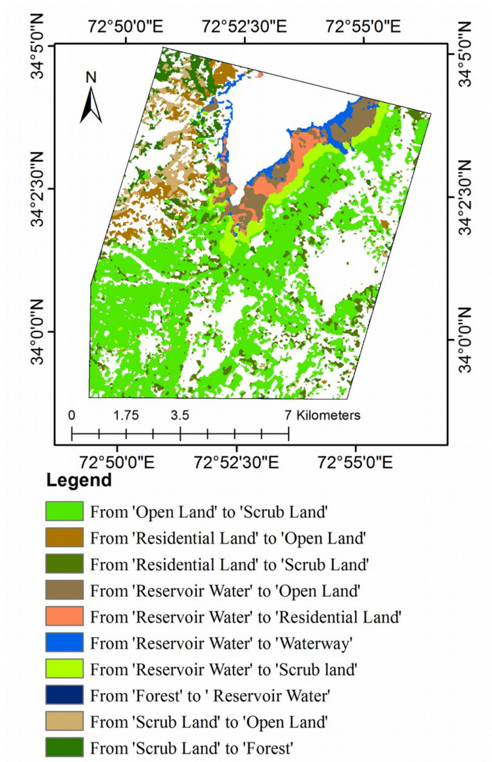

Figure 2. Winter to spring seasonal change detection

3.4 Seasonal Change Detection from Winter to Summer

Change detection matrix (Table 3) shows decrease of spatial mapping of open land 8.3%, residential land 7.3%, forest 90.27%, scrub land 1.05%, and increase of reservoir water 198.35%, waterway 18.15%. Figure 3 shows a change of category from open land to scrub land, residential land to scrub land resulted increases of vegetation in summer compared to winter. A change of category from open land to residential land, from residential land to open land, from scrub land to open land and from scrub land to residential land is due to seasonal change. Change detection from winter to summer resulted increase in dam water mapping and increase of scrub land.

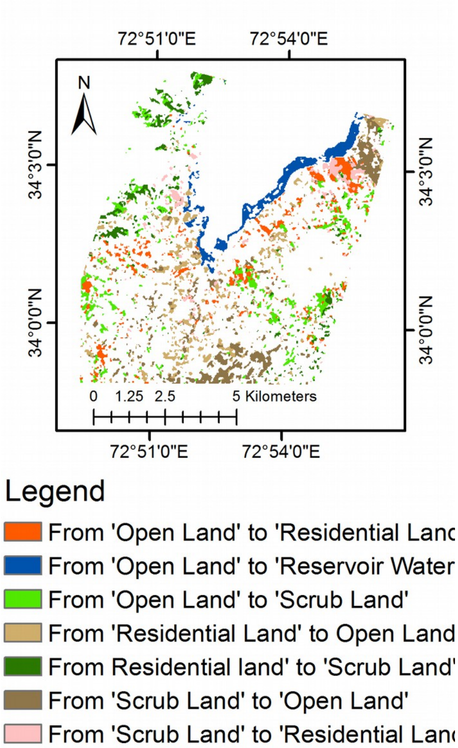

Figure 3. Winter to summer seasonal change detection

3.5 Seasonal Change Detection from Winter to Autumn

Change detection matrix (Table 4) from winter to autumn shows decrease of spatial mapping of forest 91.5%, residential land 19.8%, scrub land 17.1% and increase of open land 15.1%, reservoir water 182.7% waterway 5.9 %. Figure 4 shows category changes scrub land to open land and residential land to open land with increase in open land. Similarly, small category changes from open land to scrub land, scrub land to open land and open land to residential land resulted due to seasonal change. Change detection from winter to summer resulted increase in increase in open land mapping.

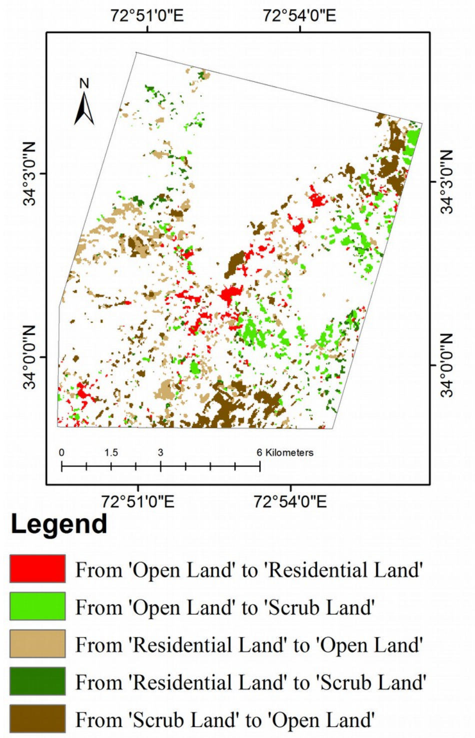

Figure 4. Winter to autumn seasonal change detection

3.6 Seasonal Change Detection from Spring to Summer

Change detection matrix (Table 5) from spring to summer shows decrease of spatial mapping of forest 48.8%, waterway 15.6%, scrub land 63.4% and increase of open land 157.4%, reservoir water 30.8% and residential land 33.8%. Figure 5 shows category changes from residential land to open land, scrub land to open land which resulted increase of open land.
Similarly category change from open land to reservoir land, residential land to reservoir land, waterway to reservoir land and scrub land to reservoir land resulted increase of reservoir water. A change of category from opens land to scrub land, forest to scrub land and scrub land to residential land resulted due to seasonal change. Change detection from spring to summer resulted reduction of vegetation and shallow water and increase of open land and reservoir water.

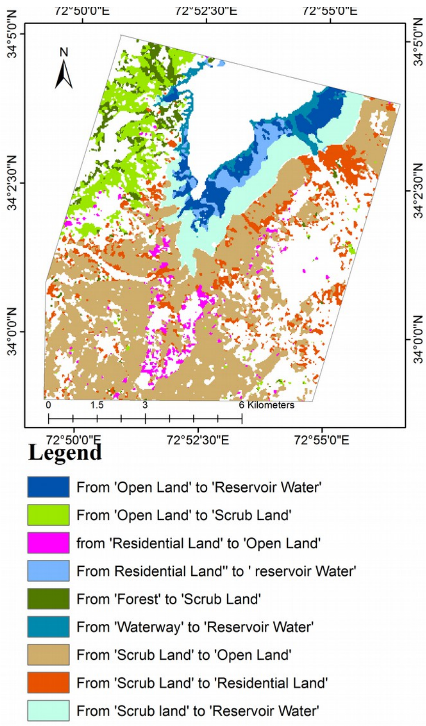

Figure 5. **S**pring to summer seasonal change detection

3.7 Seasonal Change Detection from Spring to Autumn

Change detection matrix (Table 6) from spring to autumn shows decrease of spatial distribution of forest 55.6%, waterway 24.3%, scrub land 65.6% and increase of open land 223%, reservoir water 23.9% and residential land 15.8%. Figure 6 shows category changes with increases in dam water mapping from waterway to reservoir water, open land to reservoir water, residential land to reservoir land, scrub land to reservoir land resulted increase of reservoir water. Similarly change of category from scrub land to open land and forest to open land resulted increase of open land. Small category changes from open land to scrub land and forest to scrub land resulted due to seasonal change. Seasonal change detection from spring to autumn resulted increase of reservoir water and open land.

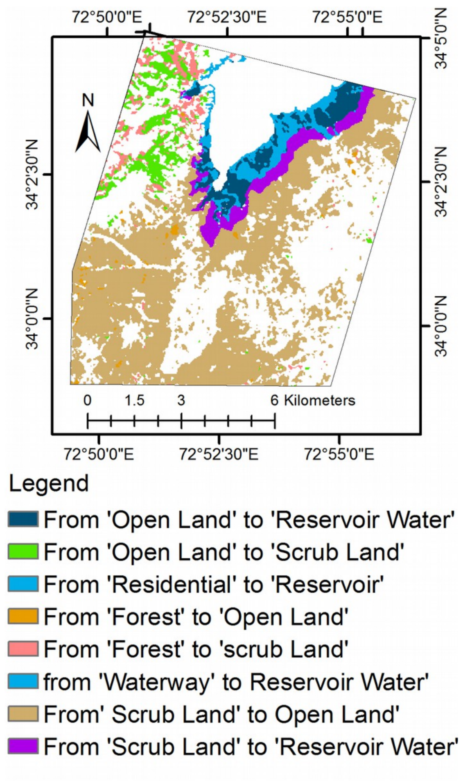

Figure 6. **S**pring to autumn seasonal change detection

3.8 Seasonal Change Detection from Summer to Autumn

Change detection matrix from Summer to Autumn shows (Table 7) decrease of spatial mapping of residential land 13.5%, reservoir water 5.2%, forest 13.2%, waterway 10.3% scrub land 6.1%, and increase of open land 25.5%. Figure 7 shows a category changes from residential land to open land, from reservoir water to open land, from waterway to open land, from scrub land to open land which resulted increase in open land.
Change of category from open land to scrub land, residential land to open land resulted due to seasonal change. Small change from open land to residential land resulted due to lack of vegetation cover the buildings and some misclassification. Seasonal change detection from summer to autumn resulted increase of open land.

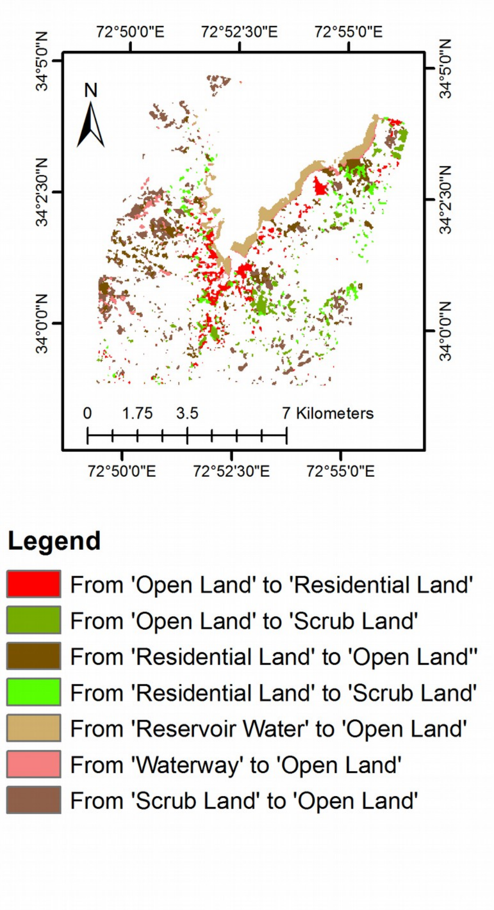

Figure 7. Summer to autumn seasonal change detection

4. CLASSIFICATION ACCURACY ASSESSMENT

The overall classification accuracy assessment using confusion matrix for OLI SVM classified data of winter , spring, summer and autumn season data were 96.7% (Kappa coefficient=0.96), 95.0% (Kappa coefficient=0.94), 92.8% (Kappa coefficient=0.91) and 92.85% (Kappa coefficient=0.90) respectively. Thus OLI data is appropriate for post classification change detection analysis.

5. CONCLUSIONS

The results of this study established the potential utility of OLI data change detection analysis The OLI SVM classified data was classified with regard to all six test classes (i.e., open land, residential land, forest, scrub land, reservoir water and waterway). OLI classified data using SVM classifier resulted higher overall accuracy (more than 91%) and kappa coefficient and thus appropriate for change detection analysis. The OLI SVM-classified data for the winter, spring, summer and autumn seasons were used for change detection analysis of six situations. Situation 1: seasonal change detection from winter to spring resulted reduction in reservoir water mapping and increases of scrub land. Situation 2: seasonal change detection from winter to summer resulted increase in dam water mapping and increase of scrub land. Situation 3: seasonal change detection from winter to summer resulted increase in increase in open land mapping. Situation 4 : seasonal change detection from spring to summer resulted reduction of vegetation and shallow water and increase of open land and reservoir water. Situation 5: seasonal change detection from spring to autumn resulted increase of reservoir water and open land. Situation 6: seasonal change detection from summer to autumn resulted increase of open land. These results established that the new OLI technology, with its higher overall accuracy suitable for post classification change detection analysis.

Table 2: Winter to Spring Season Change Detection Percentage

Class	Open Land	Reservoir Water	Forest	Waterway	Scrub Land	Residential Land
Open Land	4.5	17.5	0.1	15.7	15.8	15.2
Reservoir Water	0	48.1	91.3	0	0	0
Forest	2.6	0.6	8.0	3.6	14.1	0.8
Waterway	1.6	9.0	0	51.5	1.5	3.6
Scrub Land	88.7	14.8	0.3	11.8	63.9	29.7
Residential Land	2.3	9.6	0	17.1	4.5	50.4
Class Total	100	100	100	100	100	100
Class Changes	95.4	51.8	91.9	48.4	36.0	49.5
Image Difference	-64.4	128.0	-80.9	40.0	170.0	-30.7

Table 3: Winter to Summer Season Change Detection Percentage

Class	Open Land	Reservoir Water	Forest	Waterway	Scrub Land	Residential Land
Open Land	60.8	0.3	0.1	6.6	23.9	24.1
Reservoir Water	7.2	99.4	91.3	9.3	3.3	0.7
Forest	0.1	0	6.6	0	5.4	0
Waterway	3.9	0	0.1	53.7	0.9	4.0
Scrub Land	13.5	.1	1.66	7.2	52.8	15.4
Residential Land	14.1	0.1	0.1	22.9	13.4	55.5
Class Total	100	100	100	100	100	100
Class Changes	39.1	0.5	93.3	46.2	47.1	44.4
Image Difference	-8.2	198.3	-90.2	18.1	-1.0	-7.3

Table 4: Winter to Autumn Season Change Detection Percentage

Class	Open Land	Reservoir Water	Forest	Waterway	Scrub Land	Residential Land
Open Land	73.7	0.4	0.1	14.9	34.2	29.3
Reservoir Water	1.7	99.4	91.3	1.5	0	0
Forest	0	0	7.4	0	1.9	0
Waterway	2.6	0	0	56.8	1.4	3.2
Scrub Land	12.2	0	0.9	3.9	55.6	11.4
Residential Land	9.5	0	0	22.7	6.7	55.9
Class Total	100	100	100	100	100	100
Class Changes	26.2	0.5	92.5	43.1	44.3	44.0
Image Difference	15.0	182	-91.5	5.9	-7.1	-19.8

Table 5: Spring to Summer Season Change Detection Percentage

Class	Open Land	Reservoir Water	Forest	Waterway	Scrub Land	Residential Land
Open Land	5.2	0	6.0	3.7	52.1	14.9
Reservoir Water	27.9	99.9	2.3	36.9	11.4	12.1
Forest	1.1	0	45.6	0	0.4	0
Waterway	10.3	0	4.5	33.6	2.0	0.5
Scrub Land	43.5	0	37.2	12.3	18.6	5.5
Residential Land	11.7	0	4.7	13.3	15.1	66.7
Class Total	100	100	100	100	100	100
Class Changes	94.7	0	54.3	66.3	81.3	33.2
Image Difference	157.3	30.8	-48.8	-15.6	-63.3	33.8

Table 6: Spring to Autumn Season Change Detection Percentage

Class	Open Land	Reservoir Water	Forest	Waterway	Scrub Land	Residential Land
Open Land	24.4	o	14.0	9.6	61.1	14.8
Reservoir Water	27.8	99.82	1.7	32.6	6.4	11.9
Forest	0	0	42.8	0	0	0
Waterway	7.5	0	2.5	33.4	2.0	0.6
Scrub Land	29.5	0	37.3	10.7	19.9	4.9
Residential Land	10.6	0	1.4	13.4	10.1	67.6
Class Total	100	100	100	100	100	100
Class Changes	75.5	0	57.1	66.6	80.0	32.3
Image Difference	223.0	23.9	-55.6	-24.3	-65.5	15.8

Table 7: Summer to Autumn Season Change Detection Percentage

Class	Open Land	Reservoir Water	Forest	Waterway	Scrub Land	Residential Land
Open Land	77.5	4.6	1.6	32.4	28.5	24.9
Reservoir Water	0	94.7	0	0	0	0
Forest	0	0	73.6	0.5	2.3	0
Waterway	0.9	0.6	0.1	53.0	2.3	2.7
Scrub Land	8.5	0	24.3	4.6	60.1	13.2
Residential Land	12.8	0	0.1	9.2	6.6	59.0
Class Total	100	100	100	100	100	100
Class Changes	22.4	5.2	26.4	46.9	39.8	40.9
Image Difference	25.5	-5.2	-13.24	-10.2	-6.1	-13.4

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