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Application of Remote Sensing and Geographical Information System (GIS) For Land Use/Land Cover Mapping and Change Detection in Geidam Local Government Area of Yobe State, Nigeria

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ABSTRACT: This workscrutinize the integration of Geographic information system (GIS) and remote sensing in mapping of land use/land cover of Geidam local Government area of Yobe state, where the changes that took place within the period was examine by processing the Landsat 7 Enhanced Thematic Mapper Plus (ETM+) of the year 2000, Landsat 8 Operational Land Imager(OLI) of the year 2016 and 2020. The images were processed in ERDAS imagine 2014 and ArcGIS 10.6 software packages the classified image was tested and the accuracy assessment was 92.45% and the Kappa (K^) was 0.9025 which is within the tolerance limit. The results after processing revealed that between the year 2000 and 2016, there is proliferation in water body, settlements, farmlands and vegetation by 0.51%, 0.06%, 1.30% and 5.30% respectively and there is diminution of 7.17% in bare soil class.However, between the period of 2000 and 2020, there is also an increase in the class of water body, settlements, farmlands and vegetation cover by 1.74%, 0.22%, 6.02% and 7.80% respectively andsimilarly there is a decrease of 15.78% in bare soil class.Thus, there is an increase on the land cover within the period which include water body, settlement, farmland and vegetation neverthelessthe decrease in bare soil which might be connected with the measures taken in combating desertification in the study area.

Keywords: Remote sensing, Geographic information system (GIS), Land use/Land cover and Change detection.

I. INTRODUCTION

1.1 Background of the Study

Change analysis of features of Earth's surface is essential for better understanding of interactions and relationships between human activities and natural phenomena. This understanding is necessary for better resource management and improved decision making (Butt, Shabbir, Ahmad, & Aziz, 2015).Remote Sensing is the science and technology for attaining evidence about an object without making physical contact with the object (Abubakar,Efron& Joseph, 2012). Remote sensing plays a vital role in change detection, of regular and irregular shape of natural feature on the ground like agricultural land, lakes, Buildings, (Li & Narayanan 2002). To obtain dependable information from satellite data, suitable classification techniques are considerable. Numerous mathematical approaches are accessible to detect and label of the pixel that change or not change (Kennedy et al., 2009). The land cover change product provides vital information to evaluate spatial and temporal distribution of a rapid change on the characteristic on the earth surface (Lupo, Reginster, &Lambin, 2001). Change detection is a system of recognising different in occurrences by checking it in different time El-Kawy, Rød, Ismail, &Suliman, (2011).Geographic Information System (GIS) is a computerized tool for capturing, storing, processing, checking, integrating, manipulating, analysing, and displaying data which are spatially referenced to the earth (Aleem, 2014). The tool that provides existing and reliable information about the land cover change and other natural resources is remote sensing and Geographical Information System (GIS) (Haack & English, 1996, Kennedy et al., 2009, Otukei&Blaschke, 2010,). Supervised classification will be used to detect land used / land cover change in Geidam town in Yobe state Nigeria.

1.2Study Area

The project location is Geidam Local Government Area, which is located within

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approximate latitude 12^0 53' 37'' and Longitude 11^0 55' 45''. The Local Government Area is bounded by north with Yunusari Local Government Area, by south with Tarmuwa Local Government Area, its bounded by west with Dapchi Local Government Area and by east with Borno State. The research area is predominantly inhibited by Kanuri, Hausa and Fulani tribe.

The Local Government lies mainly in the dry savanna belt, the weather surroundings are hot and dry during the summer.

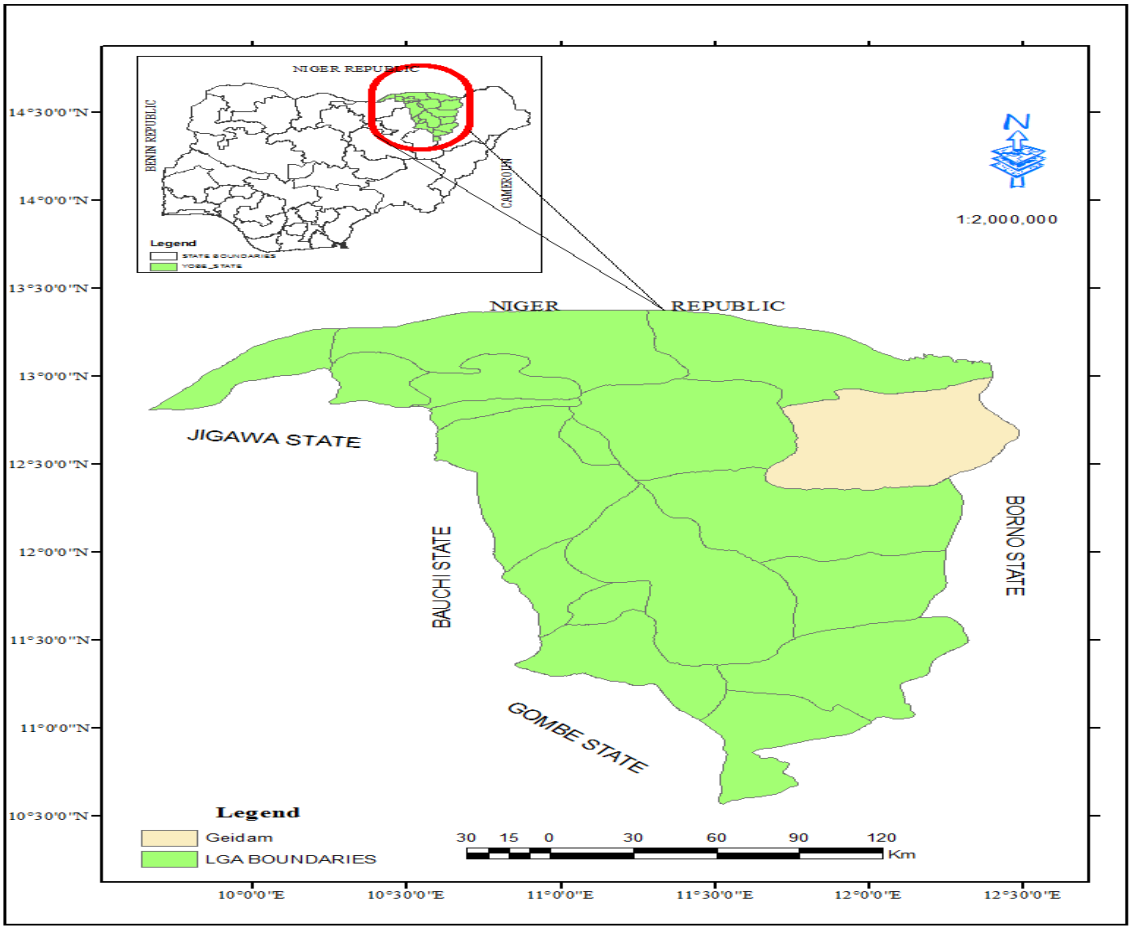

Figure 1: Location Map Showing Study Area

Source: GIS Studio Work (2020)

II. BASIC CONCEPT OF LITERATURE REVIEW

The common applications of satellite images are mapping land cover through image classification and land cover change through change detection (Song, Woodcock, Seto, Lenney, &Macomber, 2001).Land use land cover change detectionusing remote sensing attract attention in recent time (Mengistu& Salami, 2007). Gao & Liu (2010) used Landsat TM /ETM+ to detect land degradation in Tongyu county North East China andShalaby&Tateishi, (2007), applied it to monitor and map land cover and cover change in north western coast of Egypt. Similarly, Song, et al., (2013), make used of Landsat MSS/TM/ETM images of the study area to obtained data related to the lake surface for the period 1970s to 2011. MSS and TM images provide systematic arrangement of record to researchers for studying surface of water, (Li & Narayanan, 2003). Similarly, Adewuyi, (2007) used imageries from Argon, Landsat and MODIS of 1963 to 2001 to detect change in Lake Chad.In remote sensing, classification is consider as an essential process used to relate pixel values to land cover or land used classification which are presented in supportive location on the ground surface Usually assigning a pixel class is determined spectral signature of given theme, (Egorov, Hansen, Roy, Kommareddy, &Potapov, 2015). Equally, Wondrade, Dick &Tvete, (2013) considered Land cover classification as the most necessary form of Land cover analysis in the remote sensing, this include grouping of features with the specific land cover classes within the

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remotely sensed imagery to produce Land cover maps. Land Cover maps application are available in many natural features, it explains the spatial distribution and pattern of the land cover it also used to estimate areal extent of various land cover classes, (Agyemang, Heblinski, Schmieder, Sajadyan, &Vardanyan, 2010).

III. METHODOLOGY

3.1 General Framework

In order to be achieve the set up objectives, the satellite imagery and handheld Global Positioning System (GPS) data were assimilated.

3.2Instruments and Materialsused

For the successful execution of this work, the following instruments/materials.

3.2.1Hardware

1. Hand held Global Positioning System (GPS)
2. Land sat ETM+ for the year 2000, Landsat 8 OLI for the year 2016 and 2020
3. PC Laptop
4. Guide map that assist in locating the study area e.g. map of Nigeria showing Yobe State, map of Yobe State showing GeidamLocal Government Area (being the Study Area).

3.2.2Software Packages

1. ERDAS Imaging 2014 (Version)
2. ArcGIS 10.6 (Version)
3. Google Earth Pro Software.
4. Office 2016 package.

IV. PRESENTATION AND DISCUSSION OF RESULTS

4.1 Presentation of Results

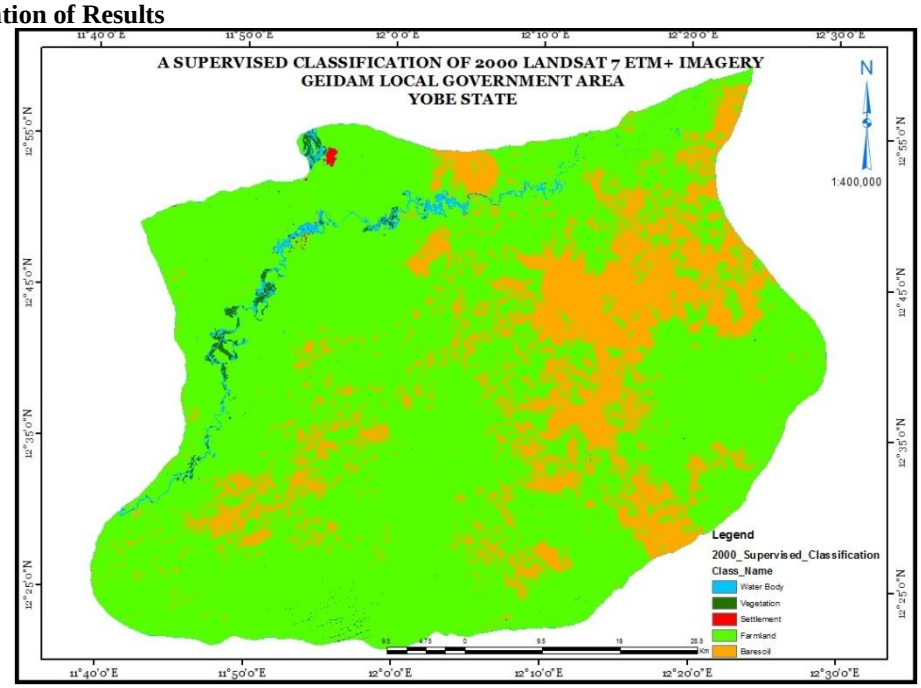

Figure 2: Supervised Classification of Landsat 7 ETM+ for the year 2000

Table 1: Classification Accuracy Result for Landsat 7 ETM+ for the year 2000

Class Name	Reference Totals	Classified Totals	Number Correction	Producers Accuracy	Users accuracy
Water Body	51	51	50	98.04%	98.04%
Settlements	13	14	13	100.00%	92.86%
Bare Soil	49	51	47	95.92%	92.16%
Farmland	53	51	49	92.45%	96.08%
Vegetation	52	51	50	96.15%	98.04%
Total	218	218	209		
Overall Classification Accuracy = 95.87%					

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Table 2: The Kappa (K^) Statistics Result for Landsat 7 ETM+ for the year 2000

Class Name	Kappa
Water Body	0.9744
Settlements	0.9240
Bare Soil	0.8988
Farmland	0.9482
Vegetation	0.9742
Overall Kappa Statistics = 0.9468 Conditional Kappa for each category	

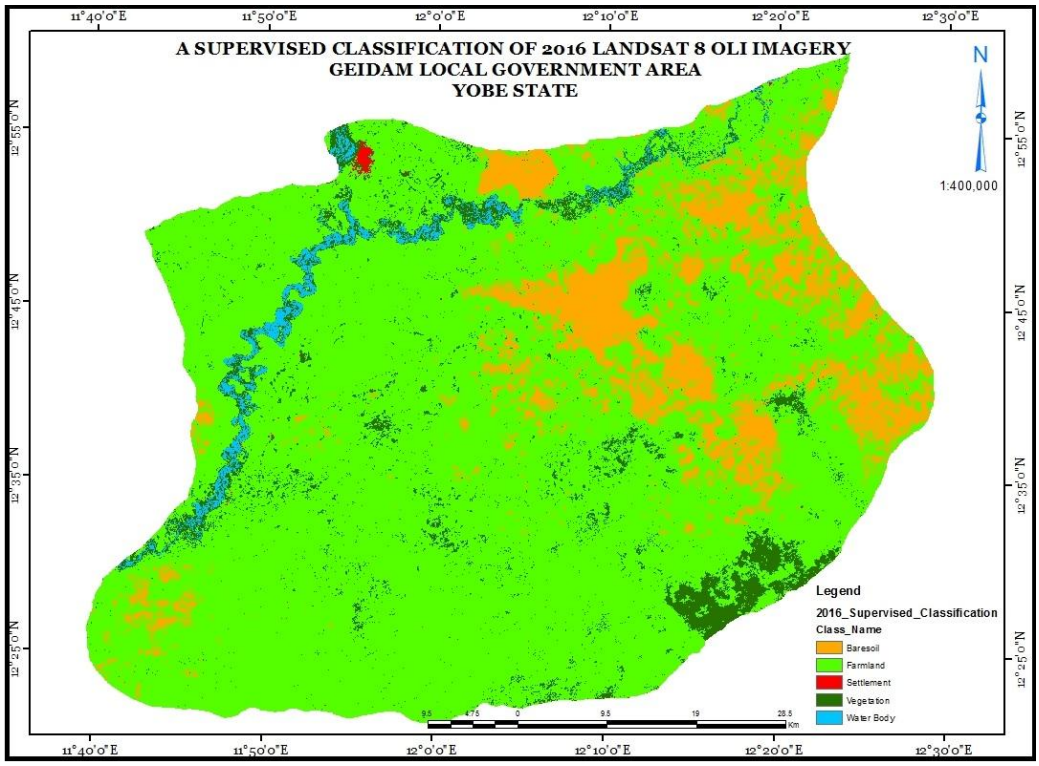

Figure 3: 2016 Supervised Classification for Landsat 8 OLI for the year 2016

Table 3: Classification Accuracy Result for Landsat 8 OLI for the year 2016

Class Name	Reference Totals	Classified Totals	Number Correction	Producers Accuracy	Users accuracy
Water Body	45	51	41	91.11%	80.39%
Settlements	14	15	13	92.86%	86.67%
Bare Soil	52	51	47	90.38%	92.16%
Farmland	50	51	46	92.00%	90.20%
Vegetation	58	51	48	82.76%	94.12%
Total	219	219	195		
Overall Classification Accuracy = 89.04%					

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Table 4: The Kappa (K^) Statistics Result for Landsat 8 OLI for the year 2016

Class Name	Kappa
Water Body	0.7532
Settlements	0.8576
Bare Soil	0.8988
Farmland	0.8730
Vegetation	0.9200
Overall Kappa Statistics = 0.8591 Conditional Kappa for each category	

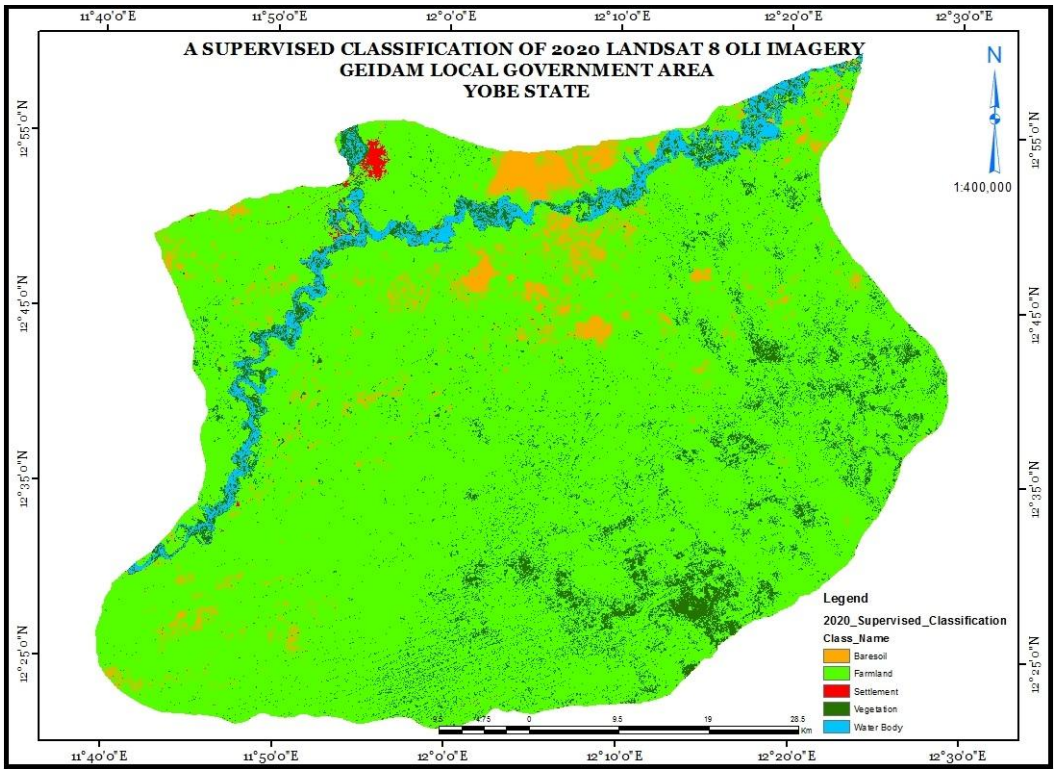

Figure 4: Supervised Classification for Landsat 8 OLI for the year 2020

Table 5: Classification Accuracy Result for Landsat 8 OLI for the year 2020

Class Name	Reference Totals	Classified Totals	Number Correction	Producers Accuracy	Users accuracy
Water Body	51	51	48	94.12%	94.12%
Settlements	8	8	8	100.00%	100.00%
Bare Soil	49	51	45	91.84%	88.24%
Farmland	49	51	47	95.92%	92.16%
Vegetation	55	51	48	87.27%	94.12%
Total	212	212	196		
Overall Classification Accuracy = 92.45%					

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Table 6: The Kappa (K^) Statistics Result for Landsat 8 OLI for the year 2020

Class Name	Kappa
Water Body	0.9225
Settlements	1.0000
Bare Soil	0.8470
Farmland	0.8980
Vegetation	0.9206
Overall Kappa Statistics = 0.9016 Conditional Kappa for each category	

Table 7: An area Calculation from Land Use/Land Cover Classes for the year 2000

S/no.	Class Name	Pixels	Area (Ha)	Percentage
1.	Water Body	55878	5029.0200	1.13%
2.	Settlements	4715	424.3500	0.09%
3.	Bare Soil	965325	86879.2500	19.90%
4.	Farmland	3795739	341616.5100	78.38%
5	Vegetation	25653	2308.7700	0.50%
	Total	435463.4700		100%

Table 8: An area Calculation from Land Use/Land Cover Classes for the year 2016

S/no.	Class Name	Pixels	Area (Ha)	Percentage
1.	Water Body	79193	7127.3700	1.64%
2.	Settlements	7159	644.3100	0.15%
3.	Bare Soil	616092	55448.2800	12.73%
4.	Farmland	3855477	346992.9300	79.68%
5	Vegetation	280562	25250.5800	5.80%
	Total	435463.4700		100%

Table 9: An area Calculation from Land Use/Land Cover Classes for the year 2020

S/no.	Class Name	Pixels	Area (Ha)	Percentage
1.	Water Body	139024	12512.1600	2.87%
2.	Settlements	15100	1359.0000	0.31%
3.	Bare Soil	199149	17923.4100	4.12%
4.	Farmland	4083815	367543.3500	84.40%
5.	Vegetation	401395	36125.5500	8.30%
	Total	435463.4700		100%

Table 10: Computation of Changes between 2000 and 2016

S/no.	Class Name	2000	2016	Difference
1.	Water Body	1.13%	1.64%	+0.51%
2.	Settlements	0.09%	0.15%	+0.06%
3.	Bare Soil	19.90%	12.73%	-7.17%
4.	Farmland	78.38%	79.68%	+1.3%

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5.	Vegetation	0.50%	5.80%	+5.30%

Table 10: Computation of Changes between 2016 and 2020

S/no.	Class Name	2016	2020	Difference
1.	Water Body	1.64%	2.87%	+1.23%
2.	Settlements	0.15%	0.31%	+0.16%
3.	Bare Soil	12.73%	4.12%	-8.61%
4.	Farmland	79.68%	84.40%	+4.72%
5.	Vegetation	5.80%	8.30%	+2.50%

Table 11: Computation of Changes between 2000 and 2020

S/no.	Class Name	2000	2020	Difference
1.	Water Body	1.13%	2.87%	+1.74%
2.	Settlements	0.09%	0.31%	+0.22%
3.	Bare Soil	19.90%	4.12%	-15.78%
4.	Farmland	78.38%	84.40%	+6.02%
5.	Vegetation	0.50%	8.30%	+7.80%

4.2 Discussion of Results

The results presented above reveals that after the classification of the imageries, the accuracy was tested for and was found to be 92.45% and the Kaffa K^ is 0.9025. The difference between the land use /land cover changes between the year 2000 and 2016 revealed that there is an increase in water body, settlements, farmlands and vegetation by 0.51%, 0.06%, 1.30% and 5.30% respectively where nit also shows that there is a decrease in bare soil class by 7.17%.

However, between the year 2000 and 2020, the result further revealed that there is an increase in water body, settlements, farmlands and vegetation by 1.74%, 0.22%, 6.02% and 7.80% respectively with the decrease in bare soil by 15.78%. Over 80% of the area is dominated by farmland.

V. CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

The aim of the research was successfully achieved through its set up objectives where the GIS and remote sensing techniques were used to processed the landsat imagery using ERDAS imagine 2014 ArcGIS 10.6 software packages where the result revealed that there is an increase in water body, settlement, farmland and vegetation by1.74%, 0.22%, 6.02% and 7.80% respectively with the decrease in bare soil by 15.78%.

5.2 Recommendations

Haven successful achieved the set up objectives, the following recommendations are hereby made.

1. Need to be monitoring the rate at which the land cover is changing within a certain period of time thereby carrying out similar work at a certain interval which can be a base for future projection
2. The report produced for this work be use by future researchers / users as a manual for doing similar work.
3. Success is a journey not a destination, therefore one man's success may be another's beginning of the journey as such, there is need for project like this to be carried out and improvement made upon.

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REFERENCES

[1]. Abubakar A.M, Efron N.G and Joseph O.A (2012); remote sensing and GIS based
[2]. Predictive model for desertification early warning in North Eastern Nigeria. NED University Journal of research, volume ix, No. 1.
[3]. Adewuyi, T. O. (2007). Examination of the spatial extent of lake Chad over Five time points. Pakistan Geographical Review, 60(1), 1–11. Retrieved from http://pu.edu.pk/images/journal/geography/files/PGR_2005_final_1.pdf
[4]. Agyemang, T. K., Heblinski, J., Schmieder, K., Sajadyan, H., &Vardanyan, L. (2010). Accuracy assessment of supervised classification of submersed macrophytes:

The case of the Gavaraget region of lake Sevan, Armenia. Hydrobiologia, 661(1), 85–96.

[5]. Aleem. K. (2014); Lecture Notes on Application of Remote Sensing (Un Published).

[6]. Butt, A., Shabbir, R., Ahmad, S. S., & Aziz, N. (2015). Land use change mapping and analysis using remote sensing and GIS: A case study of Simly watershed, Islamabad, Pakistan. The Egyptian Journal of Remote Sensing and Space Science, 18(2), 251–259.

[7]. Egorov, A. V., Hansen, M. C., Roy, D. P., Kommareddy, A., &Potapov, P. V. (2015). Image interpretation-guided supervised classification using nested segmentation. Remote Sensing of Environment, 165, 135–147.

[8]. El-Kawy, O. R. A., Rød, J. K., Ismail, H. A., &Suliman, A. S. (2011). Land use and land cover change detection in the western Nile delta of Egypt using remote sensing data. Applied Geography, 31(2), 483–494.

[9]. Gao, J., & Liu, Y. (2010). Determination of land degradation causes in Tongyu county, northeast china via land cover change detection. International Journal of Applied Earth Observation and Geoinformation, 12(1), 9–16.

[10]. Haack, B., & English, R. (1996). National land cover mapping by remote sensing. World Development, 24(5), 845–855.

[11]. Kennedy, R. E., Townsend, P. A., Gross, J. E., Cohen, W. B., Bolstad, P., Wang, Y. Q., & Adams, P. (2009). Remote sensing change detection tools for natural resource managers: Understanding concepts and tradeoffs in the design of landscape monitoring projects. Remote Sensing of Environment, 113(7).

[12]. Li, J., & Narayanan, R. A. (2002, June). Shape-based change detection and information mining in remote sensing. In Geoscience and Remote Sensing Symposium, 2002. IGARSS'02. 2002 IEEE International (Vol. 2, pp. 1035-1037). IEEE.

[13]. Lillesand, T. M. & Kiefer, R. W. (1994). Remote sensing and image interpretation (4th ed.). New York: Wiley.

[14]. Lupo, F., Reginster, I., &Lambin, E. F. (2001b). Monitoring land-cover changes in west Africa with SPOT vegetation: Impact of natural disasters in 1998-1999. International Journal of Remote Sensing, 22(13), 2633–2639.

[15]. Mengistu, D. A., & Salami, A. T. (2007). Application of remote sensing and GIS inland use/land cover mapping and change detection in a part of south western Nigeria. African Journal of Environmental Science and Technology, 1(5), 99-109.

[16]. Otukei, J. R., &Blaschke, T. (2010). Land cover change assessment using decision trees, support vector machines and maximum likelihood classification algorithms. International Journal of Applied Earth Observation and Geoinformation, 12, S27–S31.

[17]. Shalaby, A., &Tateishi, R. (2007). Remote sensing and GIS for mapping and monitoring land cover and land-use changes in the northwestern coastal zone of Egypt. Applied Geography, 27(1).

[18]. Song, C., Huang, B., &Ke, L. (2013). Modeling and analysis of lake water storage changes on the Tibetan plateau using multi-mission satellite data. Remote Sensing of Environment, 135, 25–35.

[19]. Wondrade, N., Dick, Ø. B., &Tveite, H. (2013). GIS based mapping of land cover changes utilizing multi-temporal remotely sensed image data in lake Hawassa watershed, Ethiopia. Environmental Monitoring and Assessment, 186(3), 1765–1780. doi:10.1007/s10661-013-3491-x