GEOGRAPHICAL ANALYSIS

RESEARCH ARTICLE

A Method for Assessing Land Use and Land Cover Accuracy Assessment in Identifying Grassland Boundaries in Karnataka - Using Google Earth.

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Abstract

This study examines the accuracy assessment of land use and land cover classification using Google Earth in identifying grassland boundaries in Karnataka for the year 2015. For this study, LANDSAT_8 The Operational Land Imager (OLI)Thermal Infrared Sensor (TIRS) images of the 2015 were used and analysed using ArcGIS 10.1. Supervised classification scheme was used to classify the images. Under land use and land cover categories Urban/Built-up land, Quarry/Mining Area, Crop land, Agricultural plantation, Fallow land, Evergreen/Semi-evergreen forest, Deciduous Forest, Forest plantation, Grasslands, Marshy/swampy land, Mangrove, Barren Rocky/Sheet Rock and Water Bodies/Rivers were studied. After classification of land use and land cover types, 277 points from random sampling for the year 2015 were generated in Arc GIS and converting random points to KML in order to open in Google Earth. Each random points value verified from Google Earth for accuracy assessment. Google Earth model was used to measure of how many ground truth pixels are correctly classified. For this study, Free Google Earth which was Built in Satellite images of the study periods were used. The result shows that overall accuracy or total accuracy obtained is 82. 67% with kappa statistics of 0.8102 (81.02%) in 2015 which is acceptable in both accuracy total (overall) and Kappa accuracy.

Keywords: Grasslands; Land Use Land Cover; Google Earth; Accuracy Assessment; Kappa

Introduction

The forests of Karnataka is a huge repository of natural resources. They provide different varieties of valuable daily requirements apart from causing rainfall. In spite of getting all these facilities from the forests time on time we have extracted limited resource to an unlimited extant which has resulted in extinction of so many species (Bhat 1992). Due to these, forests become grasslands. In turn grasslands are used in the name of globalization and development. In some cases, grasslands which are converted from reserved forest are continued as is (Arasumani et al. 2019). In this study, remaining forests and grasslands have been identified and Accuracy Assessment has been made.

The Land Use and Land Cover Change (LU&LCC) distribution varies in space and time. This is because physical and social characteristics of communities vary in space and time, so do land-use choices, resulting in a spatial pattern of land-use types. The study of land use and land cover (LU&LC) pattern is essential for the selection, planning and implementation of the land use schemes to meet the increasing human needs and welfare. This also provides the information for managing dynamics of land use and meeting the demands of increasing human population. Therefore, showing the results of land use and land cover (LU&LC) in the form of maps and statistical data is very important for planning, management and utilization of land for different purpose (Francis and Shetty 2017).

Land use and land cover (LU&LC) analysis can be done from processed Landsat Satellite images and Google Earth. Since remote sensed data from the earth orbit can be obtained repeatedly over the same area, they have been very useful to monitor and analyse Land Use and Land Cover Change (LU&LCC) in various regions of the earth (Tilahun 2015).

After doing land use and land cover (LU&LC) classification, the accuracy of special data should be defined. Accuracy assessment is an important step in the processing of remote sensing data which determines the information value of the resulting data to a user. Currently, researchers tend to use high spatial resolution data in order to obtain more accurate and precise result. In this regard, images with high spatial resolution from Google earth that are free to public are a good source of imagery, including satellite images (Mahdianpari et al. 2019).

Besides Google Earth, map data and positional measurement can be obtained using different methods such as conventional or modern land survey methods, Global Positional System (GPS) and Remote Sensing (RS) satellite imagery. Each of these methods is of a known positional accuracy. Google earth high-resolution imagery is important for accuracy assessment by comparing of point-by-point basis. A random set of points is generated for the area and then using Google Earth the value for each point is identified (DeLancey et al. 2019). Therefore, this study was intended to examine the accuracy of Land Use & Land Cover (LU&LC) Classification using Google Earth in case of Karnataka.

Study Area

The southern state of Karnataka is a pioneer in many fields among the Indian states (Act 1973). According to one ancient text, the poetics entitled "Kaviraja marga" which belongs to 9th century, reveals that land of Karnataka stretched from Cauvery to Godavari (D 2017). Now it is located in the western part of Deccan plateau. It has both water and land boundaries. It shares common border with Maharashtra in the North, Andhra Pradesh in the East, Tamilnadu in the South and Southeast, Kerala in the Southwest and Goa in the North West. Western part is flanked by the Arabian Sea. The State shape resembles like cashew nut. It extends Latitudinally from "11^0 31' to 18^0 45' North and longitudinally from 74^0 12' to 78^0 40' of East. Figure 1. Location Map. It is the eighth largest state of the Indian union with a total Geographical area of 1,91,791 sq. Kms, it is accounting for 5.83 percent of the total area of the country, there are 30 districts in Karnataka (Balasubramanian 2017).

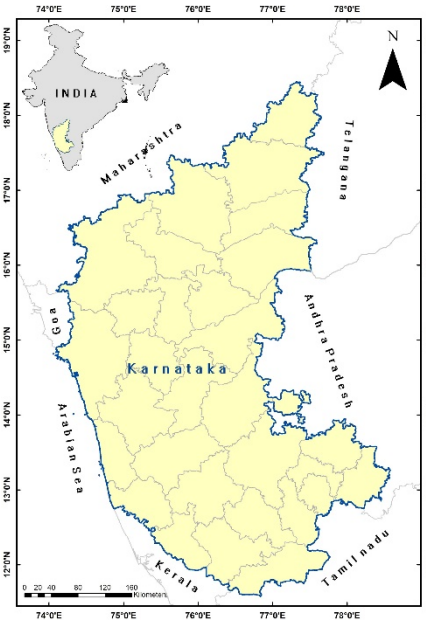

Fig. 1. Location map of the study area.

Materials and Methods

After selecting study area, primary data required for this study such as satellite images, GPS samples, field data were collected. The data obtained are listed in table 1.

Qualitative and quantitative analysis of land use and land cover changes (LU&LCC) is needed to assess the impact of changes in natural vegetation. Satellite images provide useful information on spatial and temporal variability for detecting changes in patterns on the environment in the study area. Therefore, one set of satellite images of the year 2015 is downloaded from USGS (https://earthexplorer:usgs.gov/) website which was captured by Landsat satellite (Data 2016). 2015 LANDSAT-8 contains the Operational Land Images (OLI) Thermal Infrared Sensor (TIRS) and also contains eleven bands totally and pixel size 30 meters. Around 18 satellite images are used related to study area (Kayet and Pathak 2015).

Table 1. Source and Satellite Images data collection processing.

Sl. No.	Data Type / Sensor ID	Year of acquisition	Path-Row	Resolution (m)	Number of bands	Source
1.	LANDSAT_8 The Operational Land Imager (OLI) Thermal Infrared Sensor (TIRS)	2015	143/051, 144/047, 144/048, 144/049, 144/050, 144/051, 144/052, 144/052, 145/047, 145/048, 145/049, 145/050, 145/051, 145/052, 146/048, 146/049, 146/050,146/051,	30	11	USGS

ETM: Enhanced Thematic Mapper; OLI TIRS: Operational Land Imager Thermal Infrared Sensor; USGS: United States Geological Survey

Software Used

The following software was used for the processing and analysis of data.

A. Arc GIS 10.1: Preparation of Location of the project area, Data base generation and Image classification (Barbara Parmenter Rasputnis 2016).

B. Google Earth for creating KML files and verifying of randomly generated points (Galway et al. 2012).

Methods of Data Analysis

Landsat images, mainly bands 4, 3 and 2 are used to combine to make true-colour composite images for land use and land cover (LU&LC) analysis and supervised image classification was done. After image classification was done, it was used for accuracy assessment on Google Earth maps of the year we need. Accuracy assessment was measured through matrix using user classification and reference image User's Accuracy and Producer Accuracy were measured using equation 1 and 2 respectively (Rwanga and Ndambuki 2017).

$$\text{Users Accuracy} = \frac{\text{Number of Correctly Pixels in each Category}}{\text{Total number of Classified Pixels in that Category (The Row Total)}} \times 100$$

$$\text{Producer Accuracy} = \frac{\text{Number of Correctly Classified Pixels in each Category}}{\text{Total Number of Reference Pixels in that Category (The Column Total)}} \times 100$$

Overall accuracy was measured using equation 3

$$\text{Overall Accuracy} = \frac{\text{Total Number of Correctly Classified Pixels (Diagonal)}}{\text{Total Number of Reference Pixels}} \times 100$$

Kappa can be used as a measure of agreement between model predictions and reality or to determine if the values contained in an error matrix represent a result significantly better than random. Kappa was computed using Equation 4.

$$\text{Kappa Coefficient (k)} = \frac{N\left(\sum_{i=1}^{r} x_{ii}\right) - \left(\sum_{i=1}^{r} (x_{i+} . x_{+i})\right)}{N^2 - \sum_{i=1}^{r} (x_{i+} . x_{+i})}$$

Where r = number of rows in the error matrix

X_{ii} = number of observations in row i and column (on the major diagonal)

X_{i+} = Total of observation in row i (Shown as marginal total to right of the matrix)

X_{+I} = Total of observation in column i (Shown as marginal total at bottom of matrix)

N = Total number of observations included in matrix

Results and Discussion

Based on satellite image analysis and observation of the current situation thirteen major land use and land cover (LU&LC) types were identified in the study area (Kumar 2017)(A. Veldkamp 2018). These include Urban/Built-up land, Quarry/Mining Area, Crop land, Agricultural plantation, Fallow land, Evergreen/Semi-evergreen forest, Deciduous Forest, Forest plantation, Grasslands, Marshy/swampy land, Mangrove, Barren Rocky/Sheet Rock and Water Bodies/Rivers.

Land Use and Land Cover (LU&LC) Classification for 2015

By observing land use and land cover maps classified by satellite images of Karnataka State 2015, the fallow land class is the largest land area in this classification, it covers 64303.8 square kilometres have a land area of 33.5%. After that, crop land covers an area of 38416.05 sq. km with 20.01% area. Grasslands cover an area of 37170.66 square kilometres with 19.36%. The above three classes cover the major part. The remaining classified categories are Deciduous Forest 13197.3 sq. km 6.88%, Agricultural plantation 10635.18 sq. km 5.54%, Evergreen / Semi-evergreen forest 9451.35 sq. km with 4.92%, Urban / Built-up land 5565.68 sq. km with 2.9%, Barren Rocky / Sheet Rock 5459.76 sq. km with 2.85%, Water Bodies / Rivers 3358.01 sq. km with 1.74%, Marshy / swampy land 1660.26 sq. km with 0.86%, Forest plantation 1604.2 sq. km with 0.83%, Quarry / Mining Area 1116.7 sq. km with 0.59%, Mangrove 37.58 square kilometres with 0.02% of the land area

respectively. refer table number 2.

Since we are concentrating on grasslands, if one looks at the statistics of Grass lands there can see two types of grasslands in Karnataka. First one as permanent or protected Grasslands (perennial grasslands) and the other as temporary Grasslands. These two types of grasslands together account for 19.36% of the total land area of the State, about 37170.66 square kilometres.

Table 2. Land Use & Land Cover (LU&LC) classes, their corresponding areas for 2015.

Sl. No.	LU & LC Categories	2015	
		Area (Sq. Km.)	Area (%)
1	U/BUL	5565.68	2.9
2	Q/MA	1116.7	0.59
3	CL	38416.05	20.01
4	AGP	10635.18	5.54
5	FL	64303.8	33.5
6	E/SEF	9451.35	4.92
7	DF	13197.3	6.88
8	FP	1604.2	0.83
9	GL	37170.66	19.36
10	M/SL	1660.26	0.86
11	MGR	37.58	0.02
12	BR/SR	5459.76	2.85
13	WB/R	3358.01	1.74
Total		191976.53	100

*U/BUL = Urban/Built-up land, Q/MA = Quarry/Mining Area, CL = Crop land, AGP = Agricultural plantation, FL = Fallow land, E/SEF = Evergreen/Semi-evergreen forest, DF = Deciduous Forest, FP = Forest plantation, GL = Grasslands, M/SL = Marshy/swampy land, MGR = Mangrove, BR/SR = Barren Rocky/Sheet Rock, WB/R = Water Bodies/Rivers.

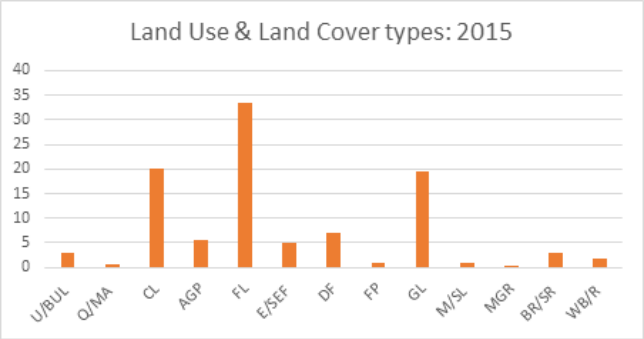

Fig. 2. Land Use & L and Cover (LU & LC) classes, their corresponding areas for 2015. *U/BUL = Urban/Built-up land, Q/MA = Quarry/Mining Area, CL = Crop land, AGP = Agricultural plantation, FL = Fallow land, E/SEF = Evergreen/Semi-evergreen forest, DF = Deciduous Forest, FP = Forest plantation, GL = Grasslands, M/SL = Marshy/swampy land, MGR = Mangrove, BR/SR = Barren Rocky/Sheet Rock, WB/R = Water Bodies/Rivers.

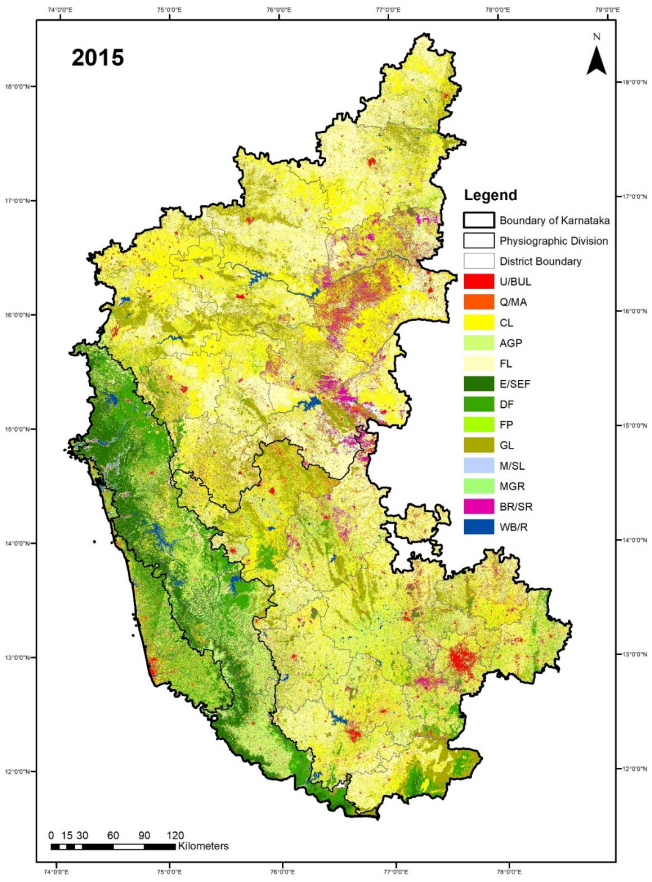

Fig. 3. Land use and land cover (LU & LC) map of the Karnataka in 2015

Accuracy Assessment of Classification for 2015

Google Earth represents a powerful and attractive source of positional data that can be used for investigation and preliminary studies with suitable accuracy and low cost. Since Images from Google Earth with high spatial resolution are free for public, they can be used directly in land use and land cover (LU & LC) mapping in small geographical extend.

Abinehand Zubairul in 2015, and the result of accuracy assessment of land use land cover with the help of Google Earth was more than 75% which is acceptable.After image is classified, generating a set of random 277 points was done in ArcGIS (Toolbox > Data Management Tools > Feature Class > Create Random Points > create extract values to points). Then the value of each random points was identified from Google Earth image.

User's Accuracy, Producer Accuracy, Overall Accuracy and Kappa percentage are reported in Table 4.

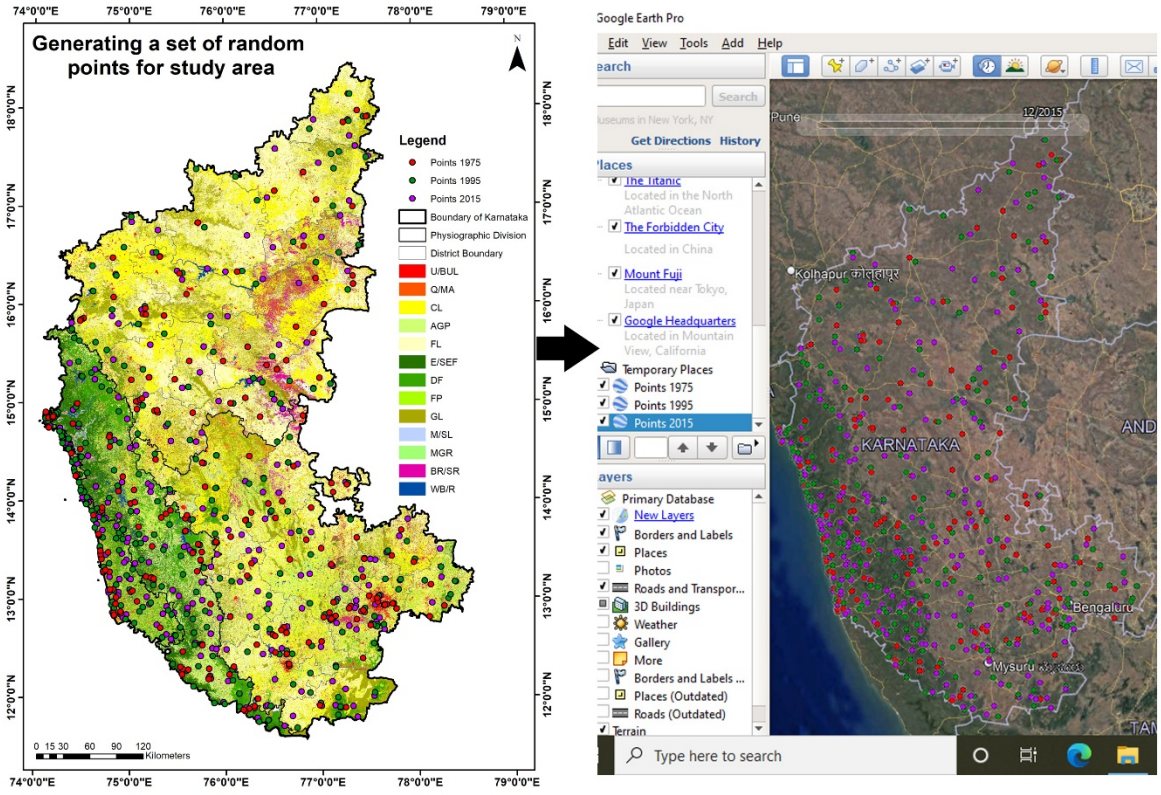

Fig. 4. Generatingrandom points in ArcGIS and opening the points in Google Earth

Table 3. Accuracy assessment of land use and land cover (LU & LC): 2015.

			Reference from Google earth 2015													
Sl. No.		**Classified**	**U/BUL**	**Q/MAq**	**CL**	**AGP**	**FL**	**E/SEF**	**DF**	**FP**	**GL**	**M/SL**	**MGR**	**BR/SR**	**WB/R**	**Total (User)**
1		U/BUL	**26**	0	0	0	0	0	0	0	0	0	0	0	0	**26**
2		Q/MA	0	**8**	0	0	2	0	0	0	0	0	0	0	0	**10**
3		CL	0	0	**19**	3	0	0	1	1	1	0	0	0	0	**25**
4		AGP	0	0	0	**10**	1	2	1	0	1	0	0	0	0	**15**
5		FL	0	0	0	0	**30**	0	0	0	0	0	0	0	0	**30**
6	**User Image (2015 Classified)**	E/SEF	0	0	0	0	0	**15**	0	0	0	0	0	0	0	**15**
7		DF	0	0	0	0	1	4	**18**	1	1	0	0	0	0	**25**
8		FP	0	0	0	2	3	0	3	**15**	2	0	0	0	0	**25**
9		GL	0	0	0	0	1	0	2	0	**32**	0	0	0	0	**35**
10		M/SL	0	0	0	0	0	1	0	0	0	**13**	0	0	1	**15**
11		MGR	0	0	0	0	0	0	0	0	0	2	**8**	0	0	**10**
12		BR/SR	0	0	2	0	2	2	1	0	1	0	0	**12**	0	**20**
13		WB/R	0	0	0	0	0	0	0	0	0	2	0	0	**23**	**25**
Total (Producers)			**26**	**8**	**21**	**15**	**40**	**24**	**26**	**17**	**38**	**17**	**8**	**12**	**24**	**277**

*U/BUL = Urban/Built-up land, Q/MA = Quarry/Mining Area, CL = Crop land, AGP = Agricultural plantation, FL = Fallow land, E/SEF = Evergreen/Semi-evergreen forest, DF = Deciduous Forest, FP = Forest plantation, GL = Grasslands, M/SL = Marshy/swampy land, MGR = Mangrove, BR/SR = Barren Rocky/Sheet Rock, WB/R = Water Bodies/Rivers

Table 4. Shows the relationship between ground truth data and the corresponding classified data obtained through error matrix report for the year 2015.

		2015			
Sl. No.	**Class**	**User's Accuracy (%)**	**Produser Accuracy (%)**	**Overall Accuracy (%)**	**Kappa (%)**
1	U/BUL	100	100		
2	Q/MA	80	100		
3	CL	76	90.47		
4	AGP	66.66	66.66		
5	FL	100	75		
6	E/SEF	100	62.5		
7	DF	72	69.23	82.67	0.81
8	FP	60	88.23		
9	GL	91.42	84.21		
10	M/SL	86.66	76.47		
11	MGR	80	100		
12	BR/SR	60	100		
13	WB/R	92	95.83		

*U/BUL = Urban/Built-up land, Q/MA = Quarry/Mining Area, CL = Crop land, AGP = Agricultural plantation, FL = Fallow land, E/SEF = Evergreen/Semi-evergreen forest, DF = Deciduous Forest, FP = Forest plantation, GL = Grasslands, M/SL = Marshy/swampy land, MGR = Mangrove, BR/SR = Barren Rocky/Sheet Rock, WB/R = Water Bodies/Rivers.

$$(K) = \frac{277(26+8+19+10+30+15+18+15+32+13+8+12+23)-[(26X26)+(10X8)+(25X21)+(15X15)+(30X40)+(15X24)+(25X26)+(25X17)+(35X38)+(15X17)+(10X8)+(20X12)+(25X24)]}{(277)^2-[(26X26)+(10X8)+(25X21)+(15X15)+(30X40)+(15X24)+(25X26)+(25X17)(35X38)+(15X17)+(10X8)+(20X12)+(25X24)}$$

$$(k) = \frac{277(229)-(676)+(80)+(525)+(225)+(1200)+(360)+(650)+(425)+(1330)+(255)+(80)+(240)+(600)}{277^2-(676)+(80)+(525)+(225)+(1200)+(360)+(650)+(425)+(1330)+(255)+(80)+(240)+(600)}$$

$$(k) = \frac{63433-6646}{76729-6646} = \frac{56787}{70083} = 0.8102$$

So, Kappa of 0.8102 means there is 81.02% better agreement than by chance alone.

Conclusion

Google Earth represents a powerful and attractive source of positional data that can be used for investigation and preliminary studies with suitable accuracy and low cost. So, Google Earth is very important for mapping of different types of land use and land cover (LU&LC) and for accuracy assessment. Accuracy assessment is very important in identifying grassland boundaries. Accuracy assessment is very important in identifying grassland boundaries. On this basis the accuracy of pasture boundaries is also determined. The pastures here are value-based and agreeable. The result of accuracy shows that total (overall) accuracy of land use and land cover (LU&LC) is 82.67% and Kappa (K) is 81.02% which is acceptable in both accuracy total (overall) and Kappa accuracy.

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